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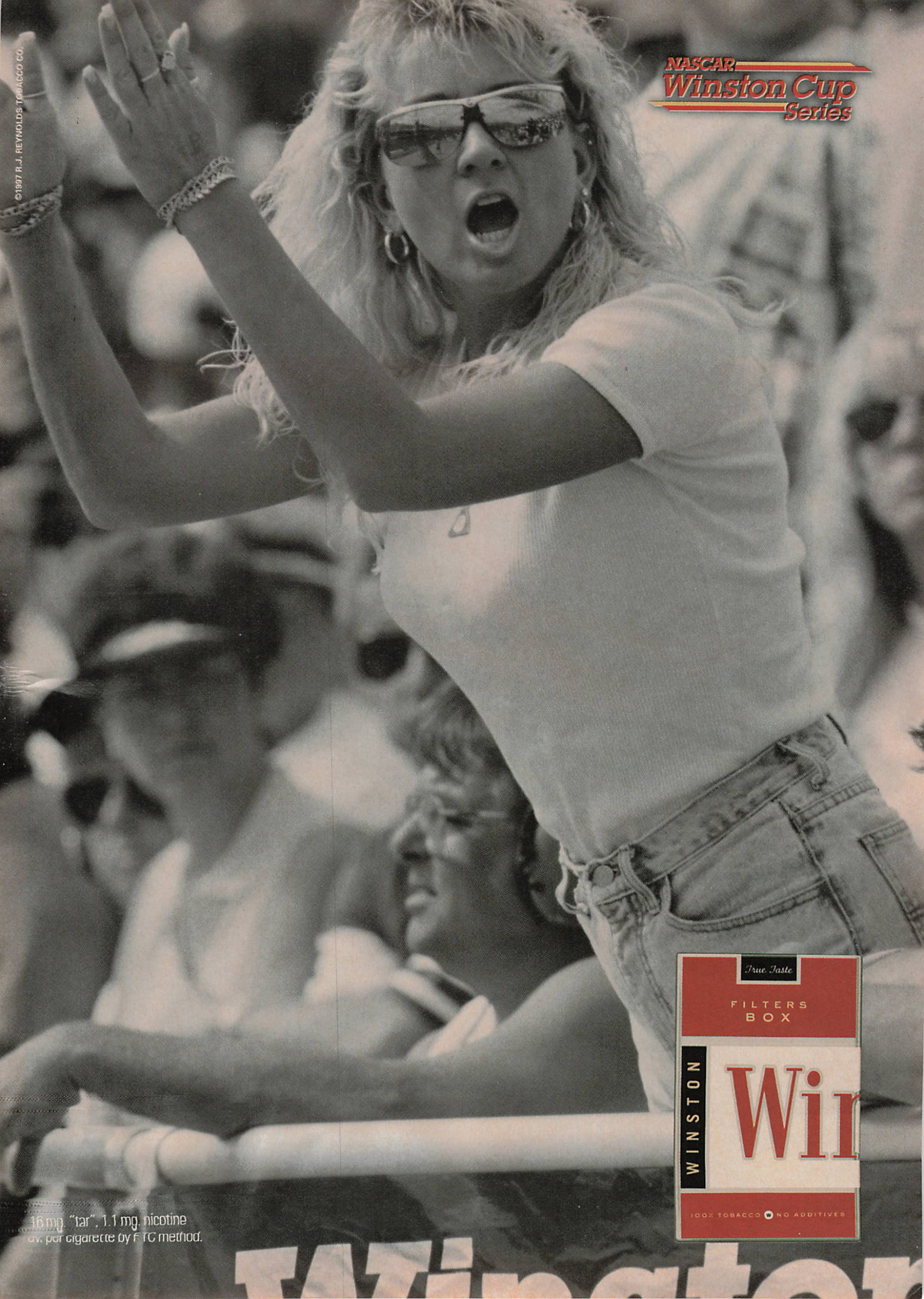
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Popular® Mechanics

OCTOBER 1997
VOLUME 174
NO. 10

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PM cover photo by Bill Delaney
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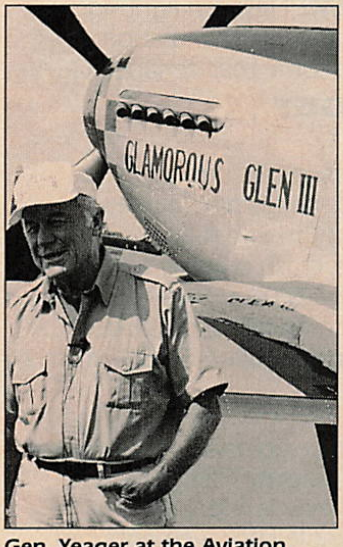
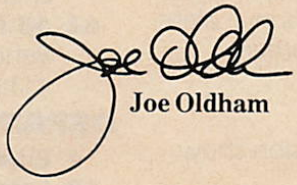
EDITOR'S NOTES

Wilson after the blast.

● **When TWA Flight 800 went down** more than a year ago, it touched off a debate that still rages. Why did the 747 blow up? Was there an explosion in the nearly empty center fuel tank? If so, what caused the explosion? Was the aircraft hit by a missile? Was it downed by a bomb on board? If so, could the bomb blast have been contained? Can planes be made more bombproof? It was this last question that caused Science/Technology Editor Jim Wilson to travel to Great Britain to witness a rather bizarre scientific experiment. British aviation authorities were going to blow up a 747 to find out if on-board bomb blasts could be contained. The results were eye-opening, to say the least. Wilson's incisive article begins on page 56.... **Wilson has been extremely peripatetic lately.** He spent the July 4th weekend at the Jet Propulsion Laboratory in Pasadena, California, awaiting the results of the *Pathfinder* mission to Mars alongside the engineers and scientists who worked for years on the project. It gave Wilson—and us—a rare inside look at the people who are the real pioneers as we journey into space. His moving chronicle begins on page 62.... **In recent years, car companies** have shown upcoming production models a year or two early and dubbed them "concept cars" for the show circuit. So if you look closely at the yearly crop of concept cars, you're most likely looking at production models a year or two hence. So for our annual new car issue, we bring you not only the new-for-'98 models but also a look down the road through the concept car looking glass—and the future is looking good. It all starts on page 66. ...**If you haven't heard about our new TV show,** check out the story on page 50. Yes, the show is called "POPULAR MECHANICS For Kids," but I guarantee that kids of all ages will enjoy it. It's just debuting around the country about the time you read this. So check your local listings for Saturday or Sunday mornings to find out when it's on in your area.... **One of our favorite guys is Chuck Yeager,** or formally, Brig. Gen. Charles F. Yeager (USAF, Ret.). Any guy who ignores a bunch of broken ribs, straps himself into a rocket engine with wings and goes and breaks the speed of sound is my kind of guy. Over the years, Yeager has written for us from time to time, and one of those articles was his personal account of that historic day, Oct. 14, 1947, when his heroics changed the world. On the 50th anniversary of that momentous day, we thought it appropriate to reprint that article. Thank you, Chuck, for everything. Till next time.



Gen. Yeager at the Aviation Heritage Air Show in Louisville in 1995. That's Gary Houbarrier's replica of Yeager's WWII P-51D in the background.



Joe Oldham

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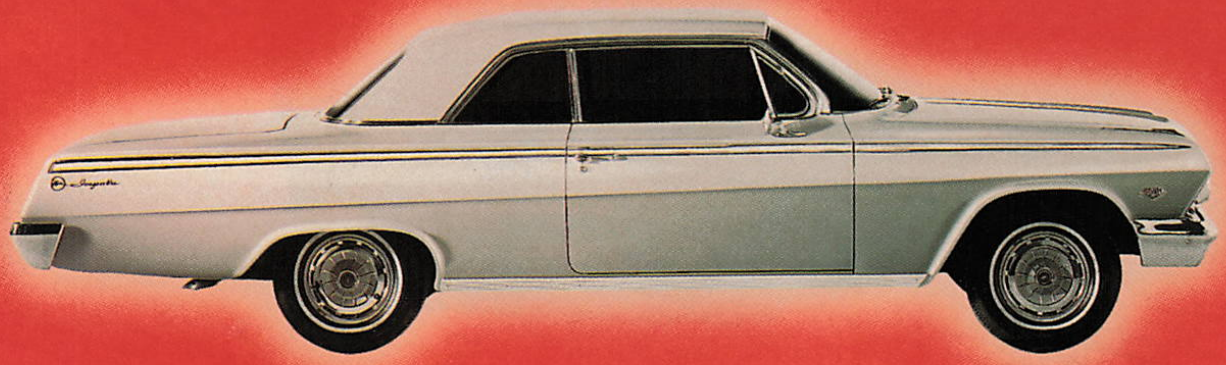

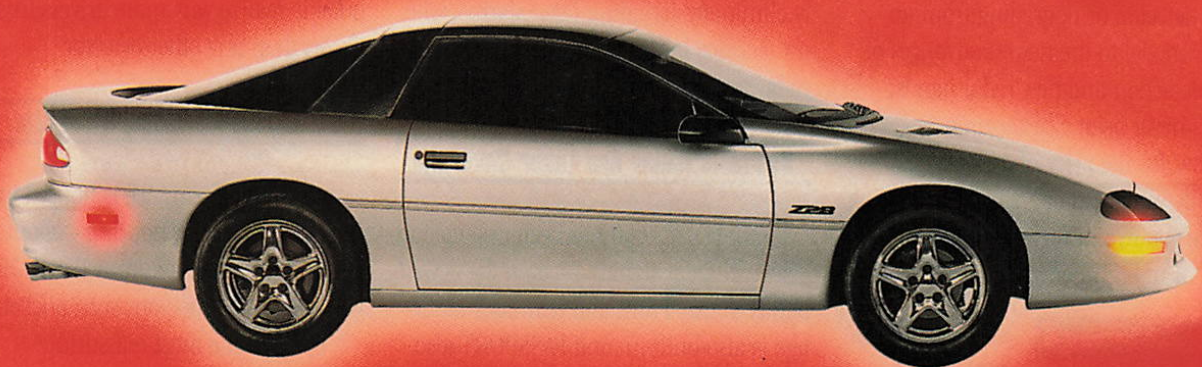

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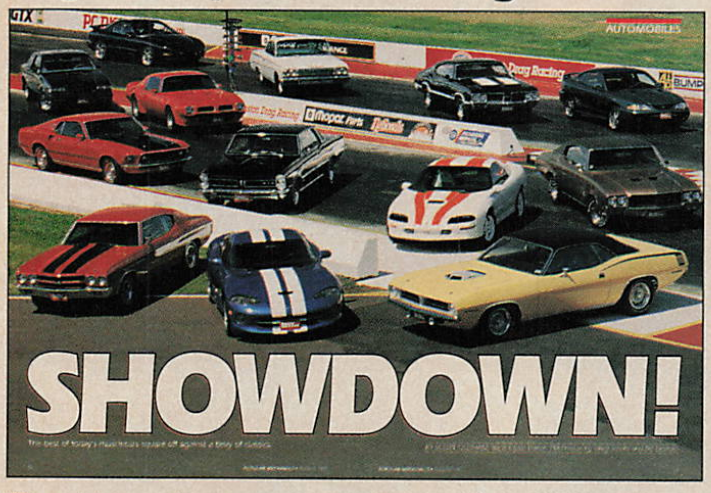

The old musclecars were, for the most part, hopped-up grocery getters. Detroit's "stuff-a-big-engine-in-a-smaller car" mentality made the quarter mile quick and big-time fun. Yet a kid pumping gas for a living could usually afford one. To these cars you compared limited-production, highly specialized street racers—the cost of which could finance a presidential election campaign. I sincerely appreciate some of the new musclecars. Yet I love my old big-block Firebird, too. It may not go around the corner very fast, but it sure is a hell of a lot of fun getting to it.

PHILIP BARTOLETTI
EMPORIUM, PA

Long live the Screaming Chicken! *—Ed.*

The term "musclecar" doesn't seem to apply to today's cars. I don't really consider the 4.6-liter Mustang a musclecar. It looks like an Isuzu Impulse and idles more like an econocar than a drag racer.

ROB BRANHAM
VIA INTERNET

The true draw of musclecars of the past is not what they could do off the showroom floor, but what an inventive individual could do with them. I remember well high-school hallways filled with young men comparing notes as to what they were going to do next with their engines or transmissions to try and get just that much more performance out of them. With today's musclecars, what you see is what you get. That sort of inventiveness is not allowed, nor is it feasible, given their complexities.

MIKE BETHEL
PHOENIX, AZ

Unless you're a computer programmer. *—Ed.*

Your test Camaro Z28 SS ran 6.18 seconds for 0-60 acceleration. It ran 4.96 in other magazines. These cars have run circles around the new Mustangs for a number of years now, and I'll guarantee the newest Camaros will run circles around most other sports cars.

MATTHEW RATKOWSKI
MILWAUKEE, WI

I don't think PM has "ended the discussion once and for all" regarding contemporary-versus-classic musclecar performance. You only opened up a whole new can of worms.

DAN KRAMER
HAM LAKE, MN

I could not believe you did not include a Corvette—*any* Corvette. Having been a teenager in the mid-'60s, there was one car that everyone wanted but only a few could have. That was the Vette.

KENNETH COLEMERE
SAN ANTONIO, TX

In the past, the old cars were always on top, but that is not the case anymore. In fact, if you bolted on a set of slicks and changed the rear gears to a 3.90 or so on the Viper GTS, low elevens would be possible. Show me *any* car from the past that could do that. All this and decent gas mileage. How can you beat it?

FRANK SZYMKOWSKI
VIA INTERNET

You must not be a country music listener or you would not have made the statement about *409* being the only song ever written about a car engine. I would bring to your attention the current country charts and the tune *455 Rocket* by Kathy Mattea. For a ride in the Viper GTS, I'll forgive you.

JAMES MICHAELS SR.
VIA INTERNET

Kathy who? Did she used to sing lead with The Roommates? *—Ed.*

(Please turn to page 12)

Letters are subject to editing for length, style and format.

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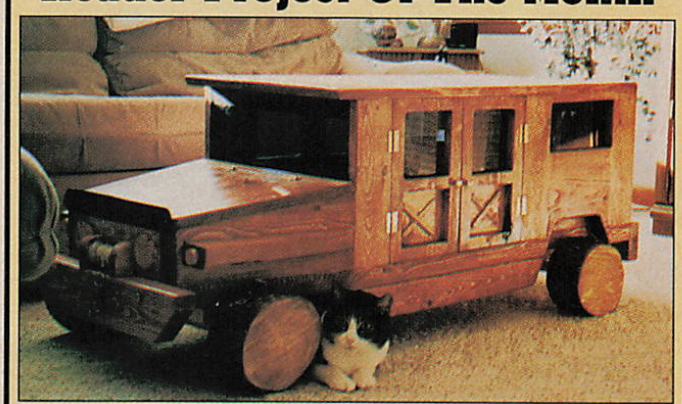
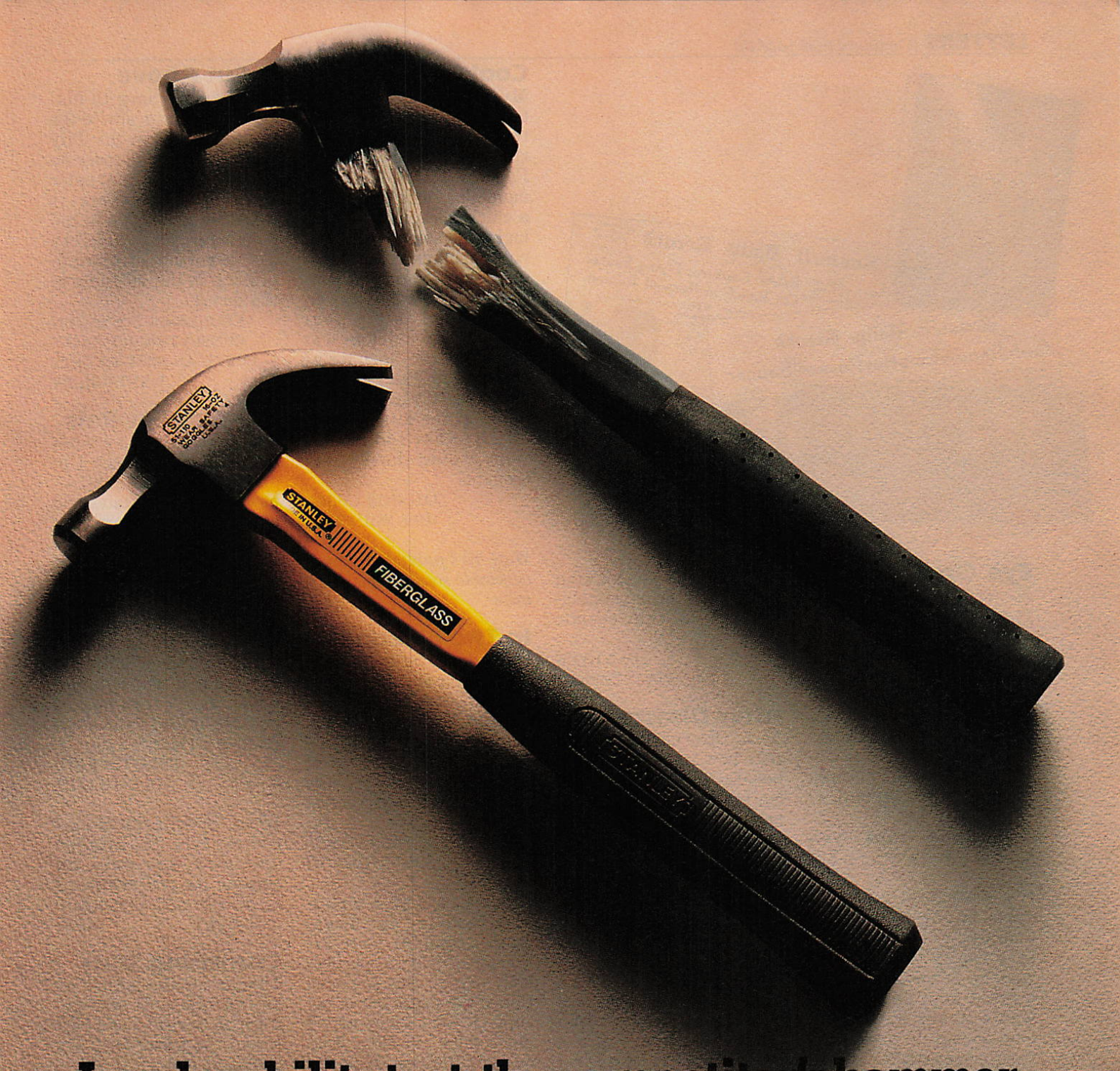


My wife asked me if I would build her a new coffee table, so I asked her if I could get a little creative. I built it out of standard knotty pine in the shape of a truck. The hood, doors and tailgate all open for plenty of storage space inside. The box of the truck has ¼-in. plate glass over it so no surface area is lost. The table measures 48 × 24 and is 20 in. tall. The windows and bug shields are film-tinted plexiglass. The winch on the front is, unfortunately, nonfunctional.

JIM BORSON
DULUTH, MN

If your project is chosen as Reader Project Of The Month, you will receive a Stanley Home Improvement Kit, complete with hand and decorating tools, valued at more than $200. For your project to be considered, please send a clear, color photo and brief description to: Reader Project Of The Month, Popular Mechanics, 224 W. 57th St., New York, NY 10019.



In a durability test, the competitor's hammer lasted 60 seconds. If you happen to need one for longer than that, buy a Stanley hammer.

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*Overstrike test conducted by striking hammer handle against metal object. © 1994 The Stanley Works.

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Eye On The Skies

Hasn't it ever occurred to you that the alleged crash of the flying saucer was a disinformation story concocted by U.S. intelligence to convince the Soviets that we had obtained superior technology from extraterrestrial sources?

THOMAS BECHER
STRATFORD, WI

Gee, now that you mention it. —Ed.

If it weren't for you guys, spies might have to do their own work. If the military really thought you were on to something they wanted kept secret, you would never have lived long enough to print your treasonous article.

MICHAEL KIRCHNER
TIJERAS, NM

Is that a threat, Kirchner? —Ed.

I can't believe people actually referred to your article as spying. They are called satellites, people, and other countries have them and know what is going on in this country as we do in theirs.

JOHN DEAN
VIA INTERNET

To deny the existence of such craft as UFOs in a universe that contains an infinite number of stars is as ridiculous as thinking that we are the only intelligence in all that cosmic soup.

BILL HYDE
VIA INTERNET

After Disaster

As an Oklahoman, I appreciate how you didn't sensationalize the Murrah Building bombing. Folks around here are still dealing with the bombing. The emotional wounds, and some of the physical wounds as well, are still tender. Thank you.

NAME WITHHELD
VIA INTERNET

Your article on the FaAA's explanation of how the outside explosion of a bomb caused the floors of the Oklahoma City Federal Building to be pushed up, causing debris to be blown out, is laughable. Media teams covering the event gave ongoing reports of a total of three unexploded bombs inside the building that had to be removed before the wounded could be gotten out.

GENE ADAMS
VIRGINIA BEACH, VA

We Spy

I liked the looks of your spy pictures so much that I went to my Chevy dealership and bought a 1998 Corvette.

KYLE SHIPP
VIA INTERNET

Cooking With PM

My husband and I decided to barbecue. He came into the kitchen flipping through the pages of POPULAR MECHANICS, mumbling something about a chicken recipe. I laughingly said something about rolling chicken in motor oil—how appetizing. However, after reading it over, we decided to try your recipe. The chicken was probably the best we've ever had on the grill. The July 1997 PM can now be found in the kitchen with all my other cookbooks. Who would have ever thought?

JAN WILLEMSEN
DES MOINES, IA

Wait 'til I publish my fresh vegetable soup recipe. It's a killer. —Ed.

In The PMZone

Our house, built in 1900, needs a fair amount of work at the moment. The articles you put into the home improvement section of the PMZone cover almost all of it. It's a little spooky. Were you here while we were at work?

BRYAN BITTERS
SHEBOYGAN, WI

It has always been a pleasure reading your magazine. I thought your PC Tuneup article was particularly useful. But someone ripped the pages out of my copy. I don't know why I didn't think of looking it up on your PMZone Web site until now, but I'm sure glad I did. I love seeing old articles that I may have missed, and some of them are very helpful.

CARMEN LONGO
VIA INTERNET

I attempted to hook up my first ceiling fan today. Things were going well until I got to hooking up the lights. All the wires in there made me panic. I read your instructions and 5 minutes later, I had lights hooked up to my ceiling fan. And I'm still alive to tell about it.

DARRELL BEANISH
NORTH BAY, ONTARIO

A Cut Above

I'm sorry to have to disagree with your advice for pruning roses in the July issue. While some roses do thrive on such drastic pruning, for others it would be lethal. We in the American Rose Society also do not advocate severe pruning in the fall, only in the spring.

FREDERICK LORENZEN
CONSULTING ROSARIAN
AMERICAN ROSE SOCIETY
WANTAGH, NY

Big Cats For Rats

South American Nutria—or "sci-fi rats" (Tech Update, page 24, July '97)—have infested 40 states and can eat up to 3 pounds of crops in a day. I estimate that a handful of cougars and two dozen hungry bald eagles could control these pesky rats. Sure, cougars pose a small threat to unattended children and pets, but balance these small risks against the value of farmers' crops. I think the solution is clear.

CHRISTIN BOYD
VIA INTERNET

Whoa, Boyd! Let's not get panicky here. The children and pets may have an opinion on this before we turn loose all the cougars and eagles. —Ed.

Crunching Stats

Thanks for the article on ab machines. It was refreshing to read a test that sorted the wheat from the chaff and wasn't afraid to list all the shortcomings.

JOSEPH FURLONG
VIA INTERNET

Here is a compendium of POPULAR MECHANICS cover price increases:

90 years ago (1907): 10¢
60 years ago (1937): 25¢—a 250% increase
30 years ago (1967): 35¢—a 350% increase
90 years later (1997): $2.95—a 1250% increase.

Now that's progress!

JOHN LAMB
WESTERLY, RI

Or, you can read it for free on the PMZone Web site. Now that's *progress. —Ed.*

PM HOTLINES

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We're trying to make it easier for you to communicate with us. Here are some ways you can do it.

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Your written letters are always welcome. If we think your letter would be interesting to other readers, we might even print it in our Letters column (unless you request that it not be printed). Send your letter to one of our editors, who are listed by department on the masthead in the front of the magazine next to Editor's Notes. Our address is: Popular Mechanics, 224 W. 57th St., New York, NY 10019.

FAX MACHINE

If you have access to a fax machine, you can fax correspondence to us. Our fax number is 212/586-5562, and it's available 24 hours a day.

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World Wide Web

Computer users with a connection to the World Wide Web can log into our Web site, The PMZone. After a recent expansion of content in all of our departments, there are now more than 10,000 text, graphics, software and digital movie files to browse through. Every day, you will find a new feature drawn from the Tech Update section. In addition, you'll find exclusive coverage of breaking stories from any one of our departments: Automotive, Science/Technology, Home Improvement, Outdoors or Electronics/Photography.

If you like POPULAR MECHANICS magazine, there is sure to be something for you in the PMZone. To log in, simply launch your browser software (we recommend using Netscape 3.0) and open the following URL: http://popularmechanics.com. We are also part of Hearst's full-service information network, HomeArts. Check it out at http://homearts.com.

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YOU'RE LOOKING AT the difference between Jack Daniel's Tennessee Whiskey and a Kentucky bourbon.

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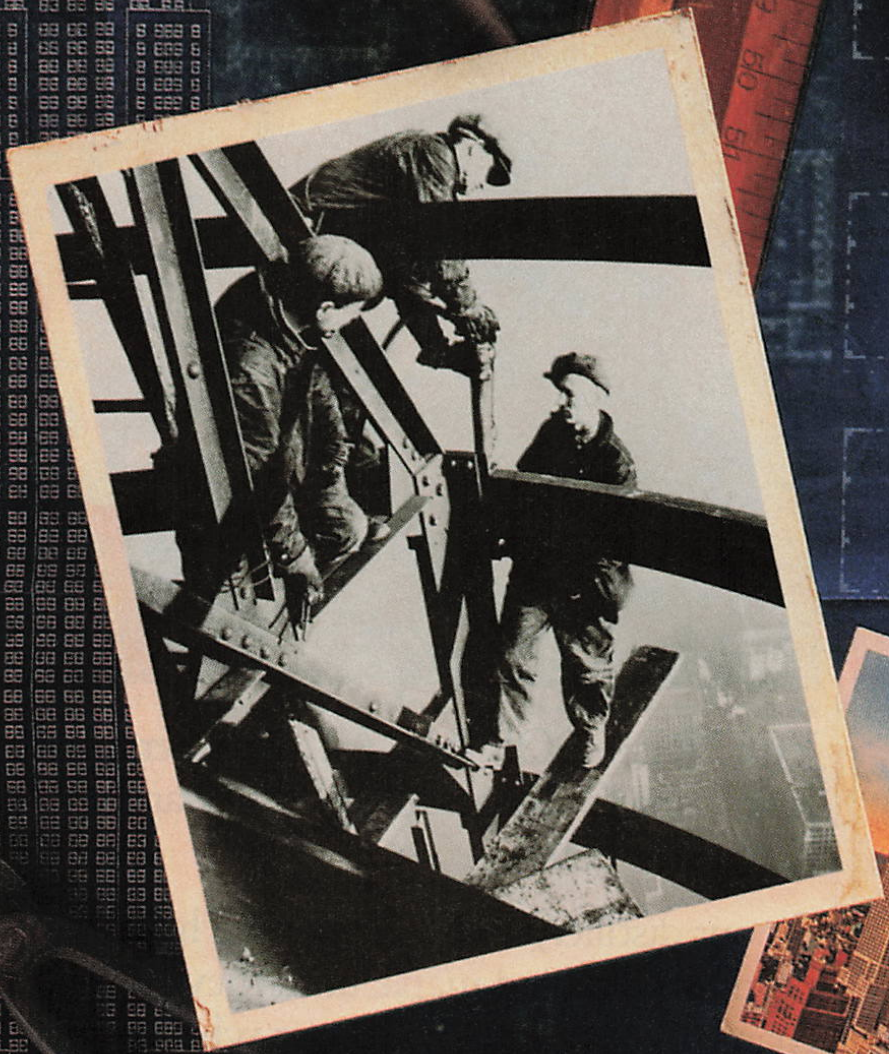
MAY 16, 1930 NEW YORK, NY

YOUR JOB IS TO STRADDLE A BEAM



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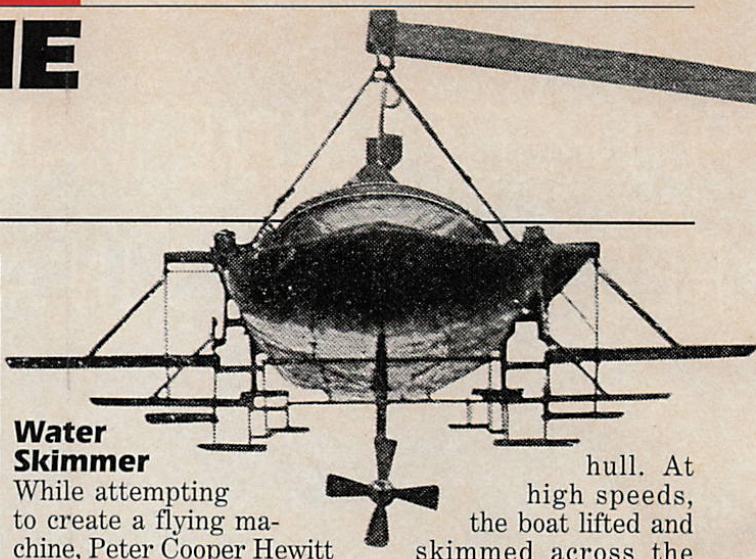
WHERE THE PAST COMES ALIVE™

TIME MACHINE

90 YEARS AGO: OCTOBER 1907

Boat Bathing

Keeping one of the most important means of transportation in tiptop shape was never an easy job, especially when it was over 800 ft. long. Our feature story detailed the upkeep of major oceanliners. These steel whales had to be hauled into a dry dock after each voyage to have barnacles and other marine growth removed by hand. The inside decorations were also checked, washed and inventoried before new passengers could board.



Water Skimmer

While attempting to create a flying machine, Peter Cooper Hewitt stumbled on this gliding boat. Instead of the body of the 27-ft. craft cutting through the water, it was supported by planes attached to steel arms extending 18 in. below the hull. At high speeds, the boat lifted and skimmed across the water on its lowest planes, avoiding waves and turbulence. A rough model topped the speedometer at 38 mph, although engineers estimated the final cruising speed to be 60 mph.

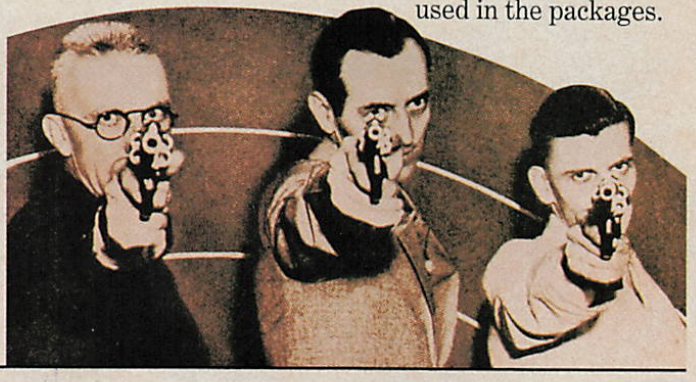
60 YEARS AGO: OCTOBER 1937

Water Records

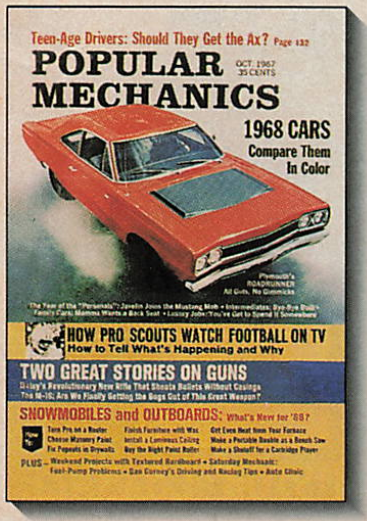
Setting records again, Sir Malcolm Campbell directed the construction of *Bluebird*—a boat designed to break the on-water speed record. Campbell, whose land-version *Bluebird* had already set speed records, equipped the speedboat with a 2150-hp 12-cylinder Rolls-Royce engine (usually found in airplanes of the time). *Bluebird*'s flotation was guaranteed by 36,000 Ping-Pong balls that had been stuffed in 48 pillowcases and placed inside the hull.

Solving Crimes

Focusing on how the smallest details can lead to important discoveries, PM took a look at the job of a forensic scientist. Known then as scientific criminology, this job employed the skills of chemists, biologists, pathologists and metallurgists to investigate crimes. PM detailed how these scientists, using microscopic dye marks, helped convict a mail bomber by connecting him to the types of nails used in the packages.



30 YEARS AGO: OCTOBER 1967

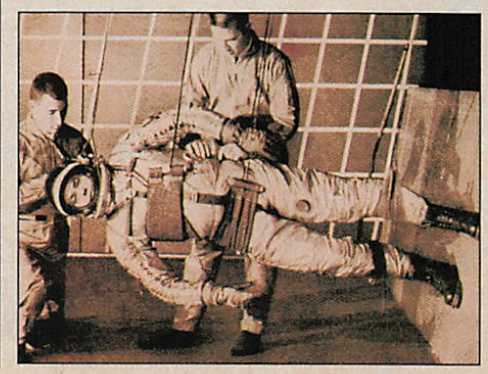

Teen-Age Drivers: Should They Get the Ax? Page 132
POPULAR MECHANICS
OCT. 1967
35 CENTS
1968 CARS
Compare Them In Color
HOW PRO SCOUTS WATCH FOOTBALL ON TV
How to Tell What's Happening and Why
TWO GREAT STORIES ON GUNS
SNOWMOBILES and OUTBOARDS: What's New for '68?

The New Classics

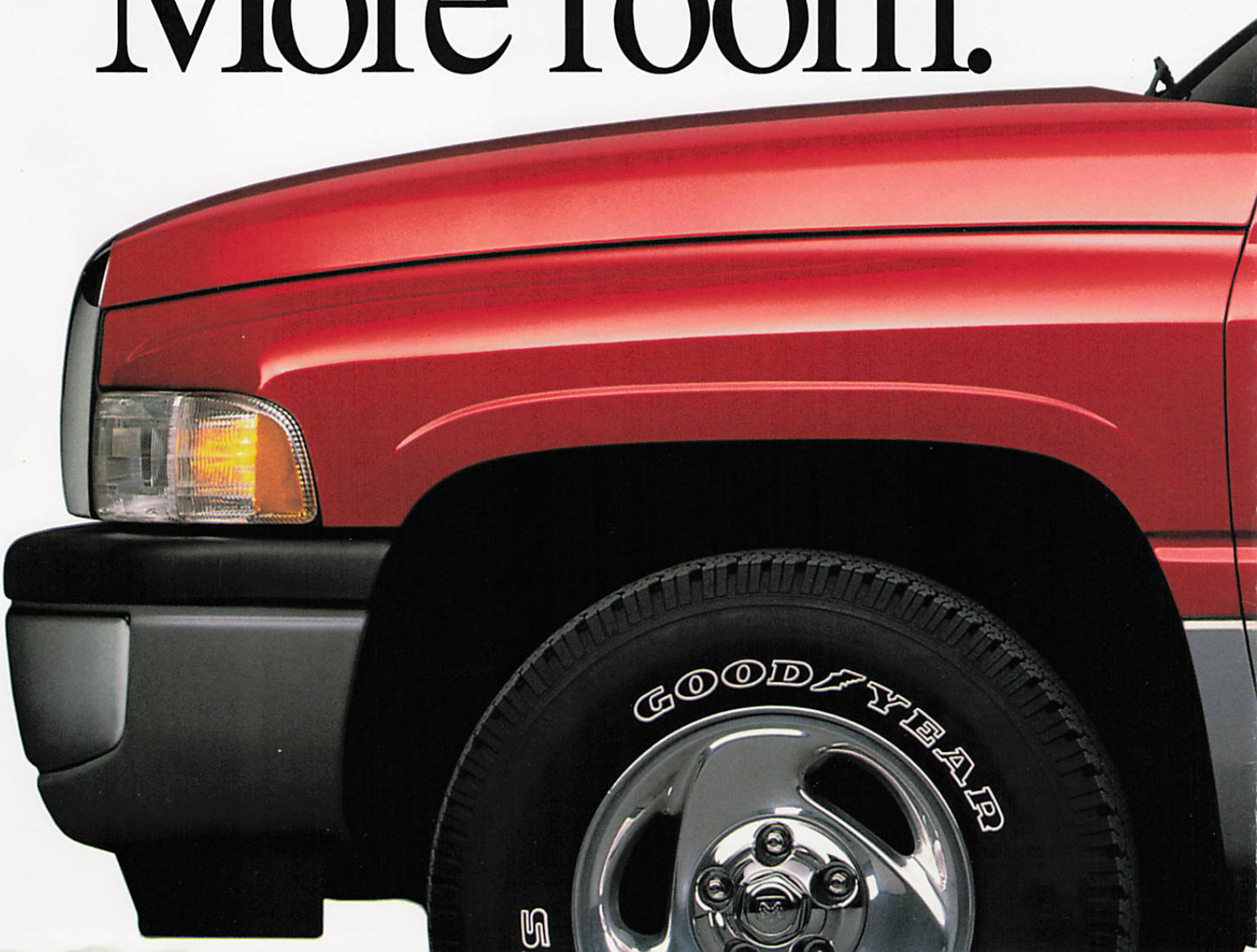
Our cover feature showed readers the new cars for 1968. Included in the list were the '68 Corvette and Dodge's '68 Charger. Both classics today, the Corvette and Charger were described as sleek and sporty at 182.1 and 208 in. long, respectively. While the Corvette impressed our drivers with its ability to hit speeds of almost 140 mph, the Charger was described as a car for a younger audience and—"in teenager vernacular"—as "tough."

Moonwalking

After a *Gemini* mission spacewalk ended early because the astronaut couldn't withstand the conditions of microgravity, NASA searched to find a way to better prepare its crews. This gravity simulator, created by a system of pulleys and slings, held an astronaut so he could walk, jump and work on an almost-vertical wall. The system simulated the feeling of moving in one-sixth Earth's gravity, the same as on the Moon. **PM**



More power.
More torque.
More towing.
More payload.
More room.

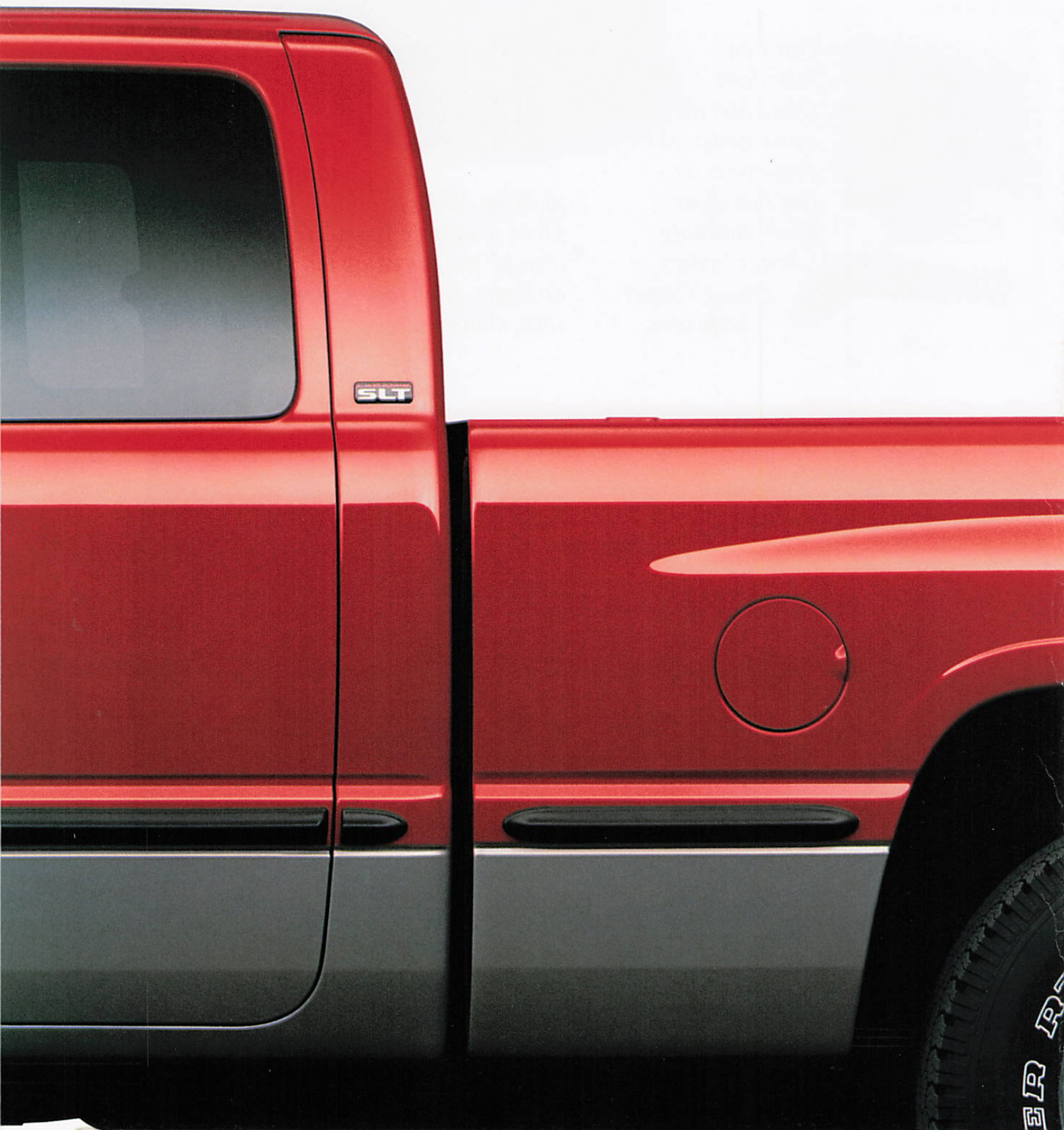


The New Dodge

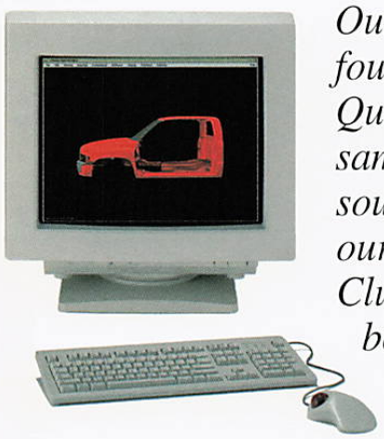
Dodge Ram already gives you more than other full-size pickups. And, now, we give you, well, still more. The new Ram Quad Cab. The first and only four-door extended cab.[1] What easily goes in one side will just as easily go out the other. And while you're passing through, take note of the new instrument panel. It appears the rules have changed all over again.

More

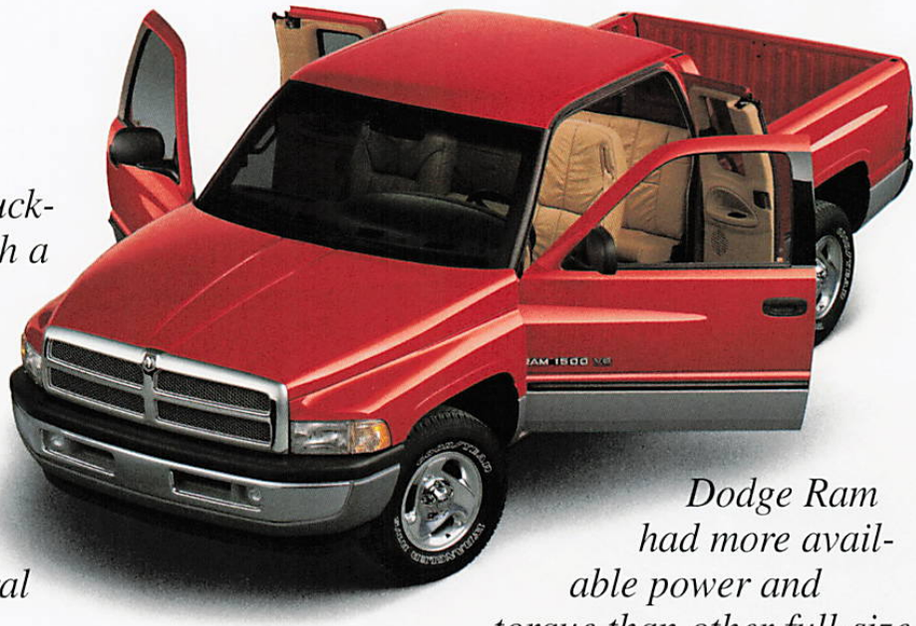
doors.



The roomiest extended cab[1] in truck-dom was made even roomier. With a glove box that's 90% larger than last year. Space-wise, we're very spacious.



Our new four-door Quad has the same structural soundness as our two-door Club. Building better bodies through super computers.



Dodge Ram had more available power and torque than other full-size pickups. More available payload and towing. More available room. Now, its advantages can also be measured by the number of doors. It's an open, open, open, open-and-shut, shut, shut, shut case.

Ram Quad Cab.™

More, and better: Ram is the only full-size pickup to win Strategic Vision's Total Quality Award™ for "Best Ownership Experience." And it's won it for three years in a row.[2]

Another first: Seat belts integrated into the front seat. One less thing to trip over when you climb in back.

Are you comfortable with a lot of power? Our Magnum® V-10 and Cummins Diesel are now available on short-wheelbase Ram 2500 Club and Quad Cabs. And horsepower ratings for our two V-8s have been increased to 230 hp on our 5.2L V-8 and 245 hp on our 5.9L V-8.

Is it all those doors that make a Ram such an easy truck to get into? Or is it the available leather-trimmed front seats that make this pickup such a comfortable choice?

Leather or not, see your friendly Dodge dealer. Or just pick up a nearby phone and call 1-800-4-A-DODGE.

If you'd rather surf, visit us on the Web, at www.4adodge.com

Always use seat belts. Remember a backseat is the safest place for children.

Ram The New Dodge

All comparisons based on data available at time of printing.

[1]Excludes Crew Cabs. [2]Winner of Strategic Vision's 1995, 1996 and 1997 Total Quality Award™ for "Best Ownership Experience" in the Full-Size Pickup class, based on its 1995, 1996 and 1997 Vehicle Experience Studies™ of 31,440 ('95), 35,652 ('96) and 31,521 ('97) Oct.-Nov. new vehicle buyers of 170+ ('95) and 200+ ('96 and '97) models after the first 90 days of ownership.

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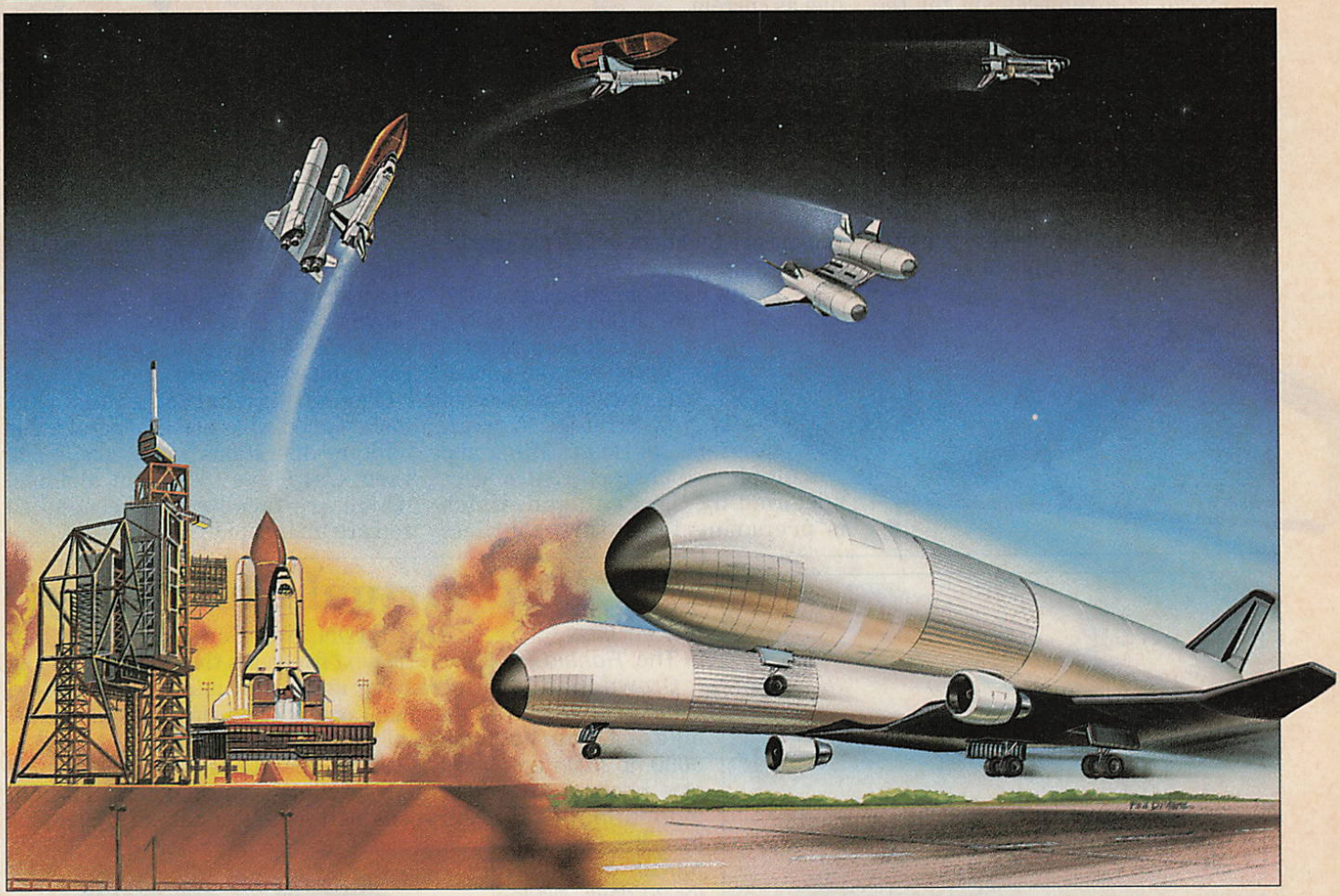
Popular Mechanics
OCTOBER 1997

TECH UPDATE

News Of Tomorrow's Technology Today



PM ILLUSTRATION BY PAUL DIMARE

NASA Mulls Fly-Back Boosters For Space Shuttle

CAPE CANAVERAL, FL—Space shuttle launches someday may provide more than the usual fiery display. NASA is studying the feasibility of using strap-on boosters that land like airplanes, rather than parachute into the Atlantic Ocean as they do now.

What's more, the fly-back boosters would burn kerosene and liquid oxygen during a launch, instead of the solid fuel used in the current design. Liquid-fueled boosters would add an extra margin of safety by making it possible for astronauts to abort during the first 2 minutes of flight. That is impossible with the solid-fuel boosters, which burn until exhausted.

"The program is in a very early stage," said Jerry Smelser, study manager for NASA. "It's very preliminary." NASA awarded contracts to Boeing Co. and Lockheed Martin Corp. for $1 million each to conduct the study. Feasibility and cost estimates will be presented by next May, Smelser said.

As in the case of the current reusable boosters, the liquid-fuel rockets would provide most of the thrust the shuttle needs at liftoff. Once their fuel was expended, they would separate from the shuttle, coast for about 9 minutes and land at the Kennedy Space Center. The new boosters would fly back with the help of jet engines, Smelser said.

Several types of liquid-fuel engines are being considered, including Boeing's F-1, which was used in the Saturn moon rockets.

Whether the unpiloted craft will have fixed or deployable wings or land attached or separately has not yet been determined. "The return flight is quite open right now," Smelser said.

It's possible that the shuttle's liquid-fuel boosters will be flight-tested by 2002, said Kennedy Space Center director Roy Bridges.

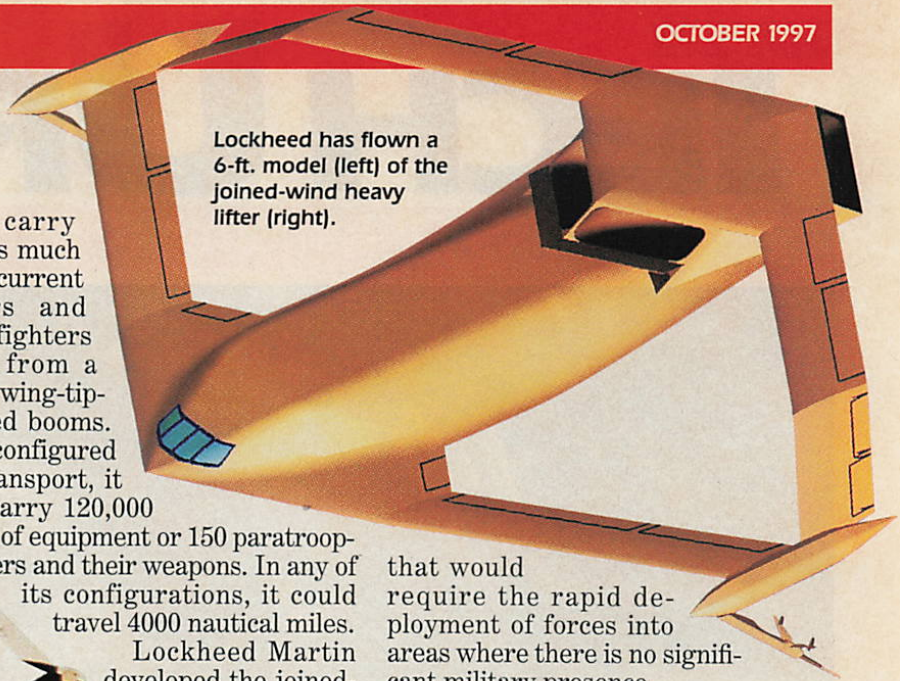
Editor/Writer: Jim Wilson
Reporters: Ken Cottrill, Fred Chesbro, Sarah Deem, Stefano Coledan, Mike Fillon, Gregory Freiheer, William Garvey, Evelyn Kanter, Mike Wallace

Highlights This Month

- **Joined Wings**—Heavy lift aircraft sport exotic designs.
- **Digital Sand**—Virtual reality helps generals plan battles.
- **Radiation Watcher**—Detector simulates a human cell.
- **Wall Climbing**—Decorations give rock fans a workout.
- **Executive Assault**—Pinstriped kin for Marine's Osprey.
- **Smart Goo**—Cold War secret gives crash dummy a brain.
- **Toner Trick**—Texas highway paved using toner fluid waste.
- **Cool Sounds**—Chilling a room with a loudspeaker's blare.

(More Tech Update on page 18)

Air Force Eyes Joined-Wing Planes



Lockheed has flown a 6-ft. model (left) of the joined-wind heavy lifter (right).

MARIETTA, GA—A radically new type of multipurpose aircraft is being considered as a replacement for the military's aging fleet of C-141 transports and KC-135 tankers.

Instead of having larger wings, the plane would use two wings in a modified canard configuration.

This design would also make for a more stable flight platform. When equipped as a tanker, such a plane could carry twice as much fuel as current tankers and refuel fighters faster from a pair of wing-tip-mounted booms. When configured as a transport, it could carry 120,000 pounds of equipment or 150 paratroopers and their weapons. In any of its configurations, it could travel 4000 nautical miles.

Lockheed Martin developed the joined-wing concept as part of its New Strategic Aircraft program. Its range, lifting and multiple-use characteristics were specified by the Pentagon, which is preparing for future conflicts that would require the rapid deployment of forces into areas where there is no significant military presence.

The lifting characteristics that make joined-wing planes desirable for military operations would also make them attractive to freight airlines, which are faced with the need to replace their rapidly aging fleets.

NOAA's New Floating Lab

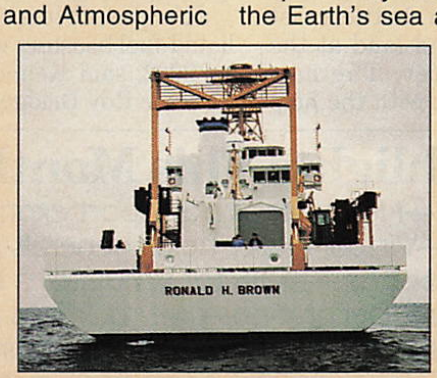
WASHINGTON, DC—Environmental scientists are beaming over their newest seagoing laboratory in the U.S. National Oceanographic and Atmospheric Administration (NOAA) fleet, the research ship *Ronald H. Brown*.

The 274-ft.-long, 3250-ton diesel-electric ship has five specialized laboratories, deck space for eight, 8 x 20-ft. experiment containers, and living space for 35 scientists and its 24-member resident crew.

The *Ronald H. Brown* has a range of 13,000 miles. Once its 6000-hp main engine brings it to a monitoring location, the ship can remain on-station for 30 days. While there, an 1180-hp rotating bow thruster guided by GPS automatically holds its position more accurately than any human helmsman.

Built by Halter Marine, the $52 million ship is the first acquisition by the NOAA in 17 years.

Although the *Ronald H. Brown* is specifically designed to explore the Earth's sea and atmosphere, the ship's first mission will be to answer a question about space. NOAA scientists hope to use the ship's 150-mile-range weather radar to determine which weather satellite provides the most accurate forecasts.



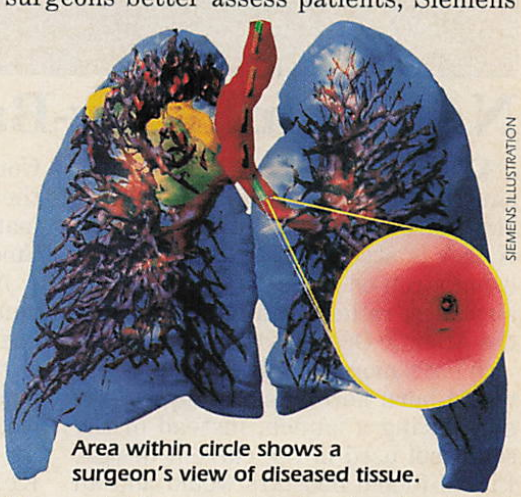
The stern of the *Ronald H. Brown* is fit with four cranes and an A-frame for deploying heavy instrument packages.

NOAA PHOTOS

Virtual Endoscopy

PRINCETON, NJ—Surgeons predict that over the next five years they will perform an increasing amount of major thoracic and abdominal operations using less traumatic, minimally invasive techniques.

But not all operations can be performed through keyhole-size incisions. To help surgeons better assess patients, Siemens Corporate Research has developed a virtual endoscopy system.



Area within circle shows a surgeon's view of diseased tissue.

SIEMENS ILLUSTRATION

Using X-rays, the system constructs a 3-dimensional model of a patient's trachea, bronchi and lungs. The surgeon then uses a computer's mouse to maneuver the endoscope (its path is marked by the green capsules in the illustration above) to the area that needs the operation.

By giving surgeons a more realistic representation of patients, the system could make it possible to use minimally invasive procedures on patients scheduled for more extensive surgical procedures.

LOCKHEED MARTIN AERONAUTICAL SYSTEMS/ ILLUSTRATION BY STEVE JUSTICE (TOP RIGHT), PHOTO BY JOHN ROSSINO (TOP LEFT)

(More Tech Update on page 20)

MAXIMUM Tool Technology.

SCHRADE TOUGH TOOL®

The new Schrade Tough Tool is made in the U.S.A. by Schrade's master craftsmen, who have been making quality knives and cutting tools like Old Timer, Uncle Henry and Cliphanger, for over 90 years. So if you're looking for a folding multi-tool that's versatile and rugged, then look no further because the Schrade Tough Tool...

- Is the easiest folding multi-tool to open and use.
- Is uniquely designed so all implements can be accessed whether the tool is folded and closed or fully opened.
- Has an exclusive locking system that makes the full sized implements extremely safe to use.
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War Games In A Digital Sandbox

ABERDEEN, MD—Computer experts at the Aberdeen Proving Ground are playing in the sand, digital sand, that is.

To give 21st-century commanders an edge in future battles, researchers here are developing a computerized version of the sand tables generals have used since armies fought with pikes.

Images appearing on the VST can be transmitted to field commander's computers.

U.S. ARMY/DOUG LAFON PHOTO

One of the problems today's commanders face is information overload, explains Maj. John R. Surdu, who is leading the virtual sand table (VST) project. "There is so much information available on the battlefield, we have to find a way to filter and integrate it to make it useful," he says.

To do this, VST presents information from battlefield sensors, reconnaissance aircraft and intelligence units on an electronic 3D color display in a $5 \times 5 \times 3$-ft. box.

VST developers believe the collapse of the former Soviet Union has made their work even more crucial. "We don't foresee a large war, but small skirmishes. We want something to help the commander fight those battles," an Army spokesman said.

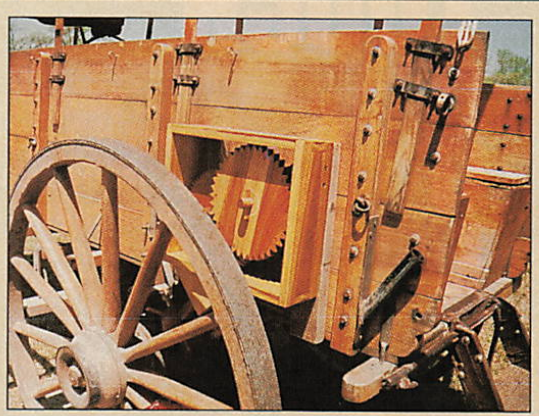
Wagon Odometer Recreated

NORTH PLATTE, NE—To help celebrate the 150th anniversary of the Mormon trek to Salt Lake City, Utah, Steve Pratt, a descendant of one of the travelers, has recreated a forgotten piece of technology—the first covered wagon odometer.

The idea for the odometer is credited to William Clayton. He distrusted the then current method of calculating mileage—counting the turns of a wagon wheel and dividing by 360—as being only as accurate as the designated counter was alert.

Clayton enlisted wagon train carpenter Appleton Harmon to build a wood gearing mechanism that moved one tooth for each mile traveled.

This year, Pratt built two replicas. Reenacting the journey, one will travel west with 30 covered wagons and hand-pulled carts. The other can be seen at the Mormon Trail Visitors Center in Omaha, Nebraska.



Each tooth on the large gear of the covered wagon odometer represented 1 mile of travel.

FRED CHESBRO PHOTO

Intel Science Fair Winners

WORCESTER, MA—Two high-school students have solved problems that have stumped the professionals.

Karen Mendelson, of Worcester, has invented a way to quickly diagnose victims of carbon monoxide poisoning. Often fatal, this type of poisoning sometimes exhibits symptoms that can be mistaken for the flu. Mendelson's battery-powered device measures light transmission through blood that is drawn from a pin prick. Unlike instruments in hospitals, it can be used in the field by emergency medical teams.

Chamberlain (above) and Mendelson (below) pose with their winning ideas.

INTEL PHOTOS

Lyle J. Chamberlain's idea doesn't promise to save lives, but it could improve them. The North Oak City, Utah, student developed a "seeing" robot that can find its way across cluttered rooms. The robots could someday be used as household aides for the handicapped.

Computer chip maker Intel was sufficiently impressed with the students' work to award them more than $40,000 in scholarship money.

Who says that teenagers who hang out in their rooms aren't making productive use of their afterschool hours?

Key Chain Tag Fills The Tank

FAIRFAX, VA—Some drivers will soon be able to pay for fill-ups by waving their keys in front of gas pumps.

They will be using Mobil's Speedpass fuel purchasing system. When a customer waves his key chain in front of a specially equipped pump, an electronic tag on the key chain becomes energized by a radio signal. It then emits a radio signal that contains a unique customer ID code.

The tag holds an ID number, but no credit card information.

MOBIL CORP. PHOTO

If the Speedpass system recognizes this ID, it looks up the customer's preassigned credit card number. The driver pumps the gas and sees the bill on his next charge card statement.

Mobil says the system—developed in cooperation with Texas Instruments and the Wayne Division of Dresser Industries—is aimed at people who dislike digging through their wallets or purses to find credit cards.

One million of these credit card key chains will be issued in the coming months.

(More Tech Update on page 22)

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Some Folks Take Life One Step At A Time. Others Take It In Two's.

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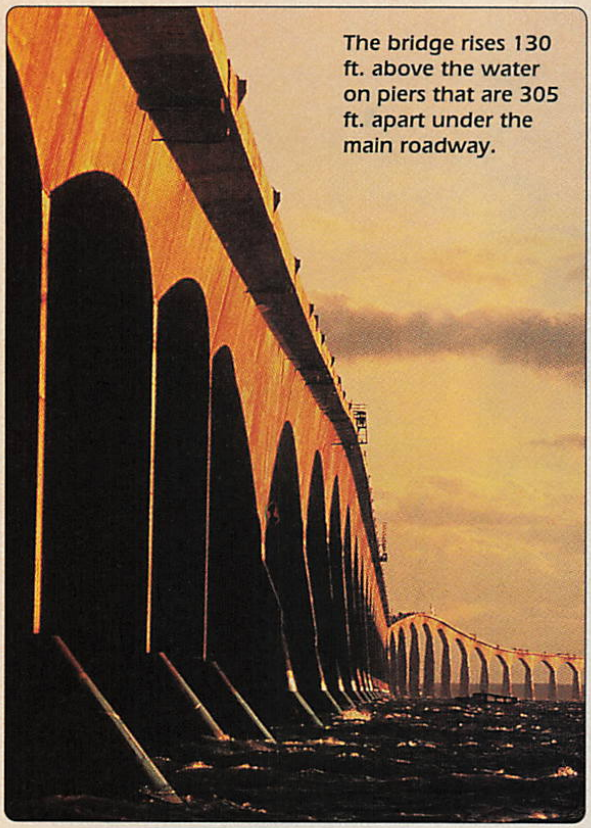
LAREDO®

Tried. And True.™

There's a good reason Laredo® Light Truck Tires are made tough with DuraShield® construction. They're put to the test every day to be as reliable, as dependable and as true as the folks who choose them.



The bridge rises 130 ft. above the water on piers that are 305 ft. apart under the main roadway.

TOURISM PRINCE EDWARD ISLAND/JOHN SYLVESTER PHOTO

GPS Helps To Build A Bridge

NORTHUMBERLAND STRAIT, CANADA—The recently opened Confederation Bridge, which links Prince Edward Island with New Brunswick, is more than a 3-lane, 8-mile-long span. The $500 million bridge is also the first made possible by GPS.

Because of the short construction season in the Northumberland Bay area, the bridge's 185 main structural elements were assembled on land. They were then loaded aboard the seagoing rigger *Svanen*, which used several GPS systems working together to provide placement accuracy within a quarter-inch, said Mirek Bursa, the project's surveying manager.

The *Svanen* carried two receivers, one on the mainmast over the center of gravity of the lifting gantry, the other on the side of the ship. Additional receivers were used on the main girders. Receivers on the pier bases and shafts helped to provide what Bursa describes as "absolute accuracy."

It took about half an hour to place each pre-fab unit, and GPS updates were made once a second. Bursa estimates that there were roughly 630,000 GPS calculations for the 44 pier bases, 44 metal tiedown templates, 44 pier shafts, 44 girders and the 43 drop-in girders that connect the main girders.

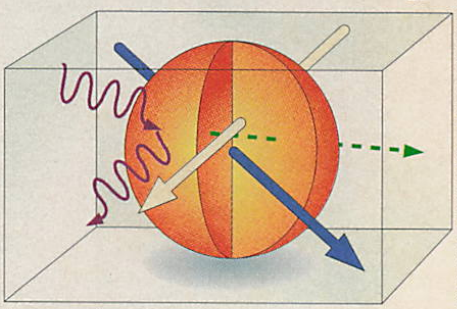
GPS also helped to provide environmental protection during the project's construction by ensuring that the dumping of dredge spoil was done safely away from lobster beds.

"We couldn't have built this bridge 25 years ago. The technology didn't exist," said Ross Gilmour, design director for the construction consortium that built the structure.

Finding A Safer Way To Space

RICHLAND, WA—Space is filled with deadly cosmic rays, but they are not equally distributed. Finding routes that expose future astronauts to the least amount of radiation will not only mean safer travel, but will also reduce the amount of shielding, thereby increasing useful payload.

To help choose the best way to Mars and beyond, a new type of radiation sensor has been developed by scientists for the Department of Energy's Pacific Northwest National Laboratory and Texas A&M University.



PACIFIC NORTHWEST NATIONAL LABORATORY ILLUSTRATION

Arrows show how radiation passes through the detector that simulates a living cell.

Unlike conventional space-borne radiation detectors that measure the gross amount of energy, the new tennis-ball-size instrument simulates the nucleus of a human cell. It can record the amount of energy imparted by passing cosmic rays, as well as ascertain the resulting tissue damage.

Larger versions of the detector have flown on space shuttle missions. One of the new models will fly on the Mir space station this fall.

Hot Wheels By Future Designers

DETROIT, MI—Compared to most forms of motorized transportation, a motorcycle is a pretty basic machine. Its simplicity is part of what made an assignment to design a motorcycle for the next century so challenging to student designers at the Center for Creative Studies (CCS) at the College of Art and Design.

The winning designs suggest that the sculptured look of today's cycles is on its way out.

First, the students spent two weeks interviewing motorcycle owners and dealers. Then, a team of designers from Honda met with the students to help them refine their ideas. Using this real-world input, the students then constructed scale models, which took an average of 225 hours to complete.

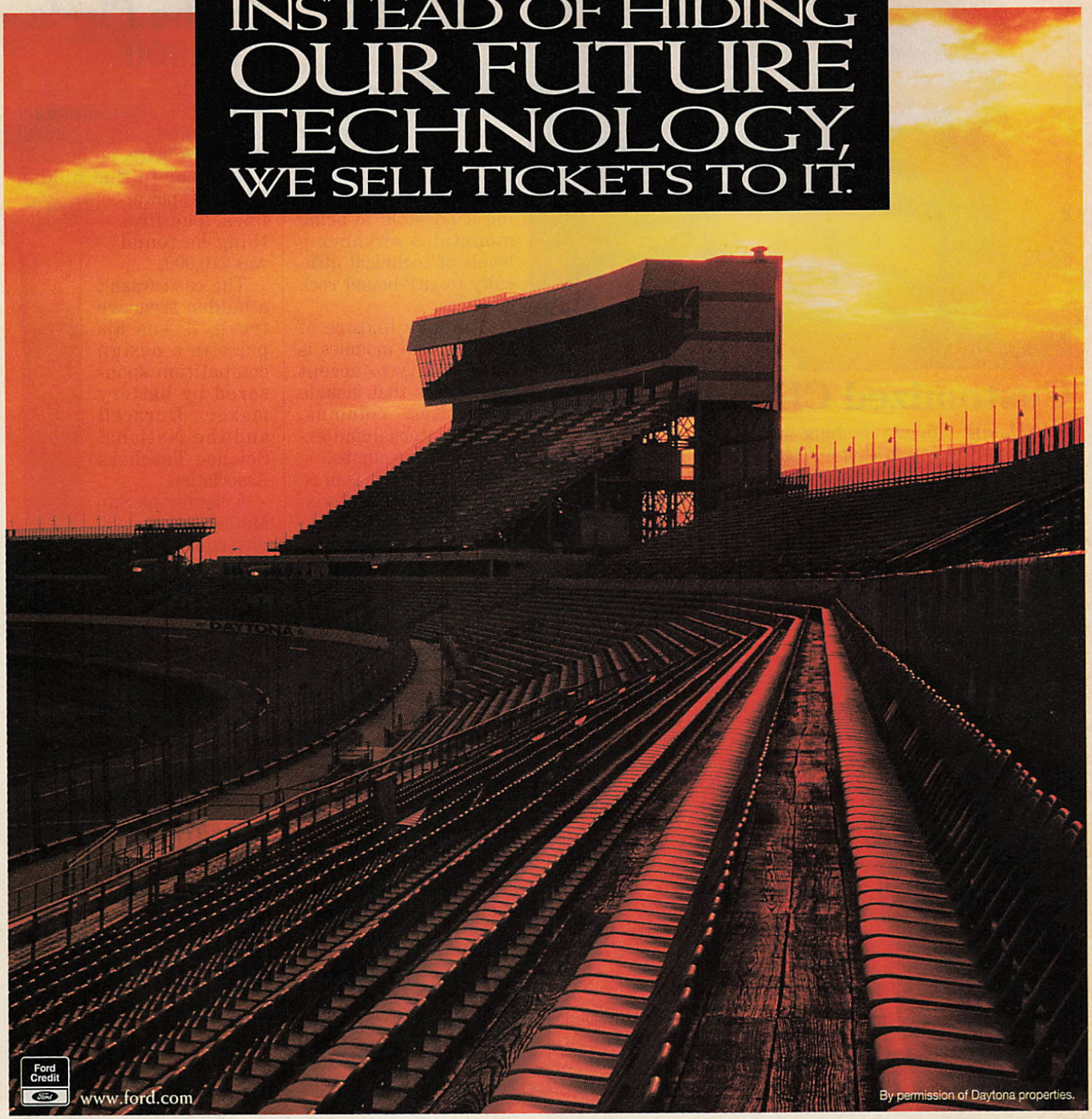
The effort paid off. "We were favorably impressed with the models," said Martin Manchester, director of Honda's motorcycle division. "They were well crafted and exceeded our expectations."

You might see one of these designs on the highway. CCS graduates helped design such favorites as the 1996 Ford Taurus, Oldsmobile Aurora and Chrysler Neon.

CENTER FOR CREATIVE STUDIES PHOTOS

(More Tech Update on page 24)

INSTEAD OF HIDING OUR FUTURE TECHNOLOGY, WE SELL TICKETS TO IT.



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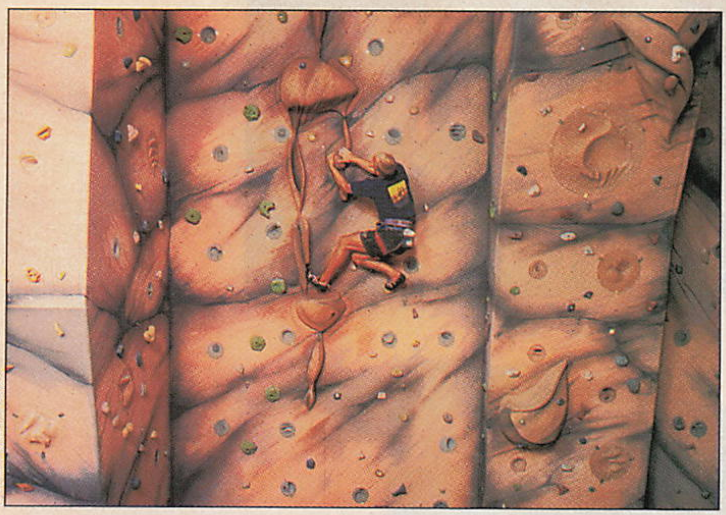


ENTRE-PRISES PHOTO

Climbers can maintain their skills on mock rock that attaches to walls.

Customized Climbing Walls

BEND, OR—Indoor climbing walls are a great way to keep in shape between trips to the mountains, but after a while they can get a bit boring.

To provide new challenges, Entre-Prises USA has introduced a line of 15 modular panels that simulate the natural holds climbers find on actual rock faces.

Made of polyester resin, these modules are designed to screw into conventional walls, making it possible to bring mountains of varying levels of technical difficulty to city-bound rock climbers.

A unique feature of the new wall modules is their ability to accept accessories that include stalactites, columns, moderate overhangs and internal and external corners for more exciting climbs.

If this variety wasn't enough reason to bring home a climbing wall, you can even select from among 15 colors, which should make future repainting jobs lots more fun.

Probe Finds $10,000

FOSTER CITY, CA—Leonard Shtargot was afraid of accidentally driving a nail into a live wire, so he built a detector to find hidden 60-Hz AC powerlines. The first thing he found was $10,000.

DURACELL/INSTA PHOTO

The cash wasn't a hidden treasure trove, it was his prize in a design competition sponsored by battery maker Duracell and the National Science Teachers Association.

A senior at San Mateo High School, Shtargot said that he learned about tuning in on electromagnetic waves while working part time at a medical instrumentation company.

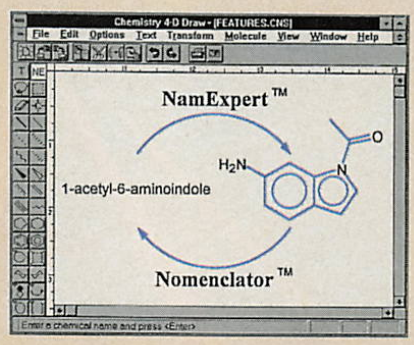
The device, which took the second-place award, is essentially a radio tuned to 60 Hz—the frequency of powerlines. It signals the distance from a live wire with an audible, variable frequency tone.

Shtargot built a prize-winning AC line detector from about $20 worth of common electric parts.

Software Names Chemicals

SAN DIEGO, CA—For consistency, chemists long ago agreed upon a strict set of rules for naming compounds.

Now, ChemInnovations Software has found a way to make it easier to identify these names and use them in reports. To name a compound, the user types in the names and quantities of atoms that make up a specific molecule. The software responds with the correct international name, which also identifies the bonding patterns among the atoms.



CHEMINNOVATION SOFTWARE PHOTO

ChemInnovations' software runs on Mac- and Windows-equipped PCs.

The program also allows a chemist to enter a compound's name and have the computer draw its proper structural formula—using one of three standardized formats.

However, it makes no promise of helping with pronunciation. Try saying "4-oxoheptanedioic acid."

Shocking Pain Relief

NEW BRIGHTON, MN—The pain of repetitive motion injury (RMI), the computer-age equivalent of writer's cramp, may have met its match in a new type of battery-powered shocking device.

Also called cumulative trauma disorder, RMI is associated with sitting for long periods in awkward positions while using a keyboard. Sufferers are usually advised to apply ice and take generic pain relievers.

Rehabilicare, the product's developer, says the CTDx Electrostimulation System relieves the discomfort by delivering closely timed electric shocks that produce a mild tingling.

The company stresses that CTDx is an early-stage pain treatment, not a cure, for RMI.

REHABILICARE PHOTO

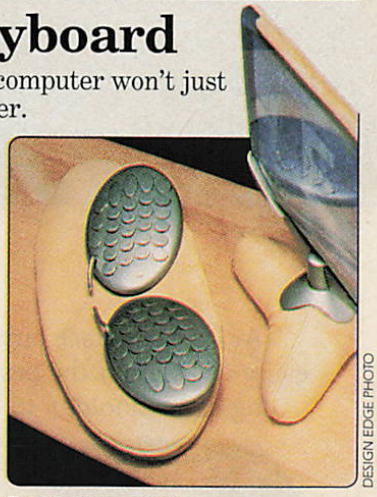
Shocks improve blood flow and nerve conduction through the carpal tunnel.

Designer Keyboard

AUSTIN, TX—Your next computer won't just be smarter, it will be prettier.

The reason, says designer Mark Kimbrough, is the trend toward home offices. "Conventional computer designs fail to take advantage of this design opportunity," he says.

His solution: Make the plain beige PC look more like—to use his term—"functional sculpture." To illustrate this, Kimbrough's firm, Design Edge, has introduced the Echo. The PC's enclosure uses leather beanbags to support a split, wireless keyboard and a flat-screen LCD monitor.



DESIGN EDGE PHOTO

Besides its artistic appeal, Kimbrough says the Echo will be less fatiguing to use.

Before you dismiss beautiful computers as a fad, consider this: The Design Edge client list includes IBM, Dell, Texas Instruments, Toshiba and Compaq.

(More Tech Update on page 26)

Cruelty to animals.

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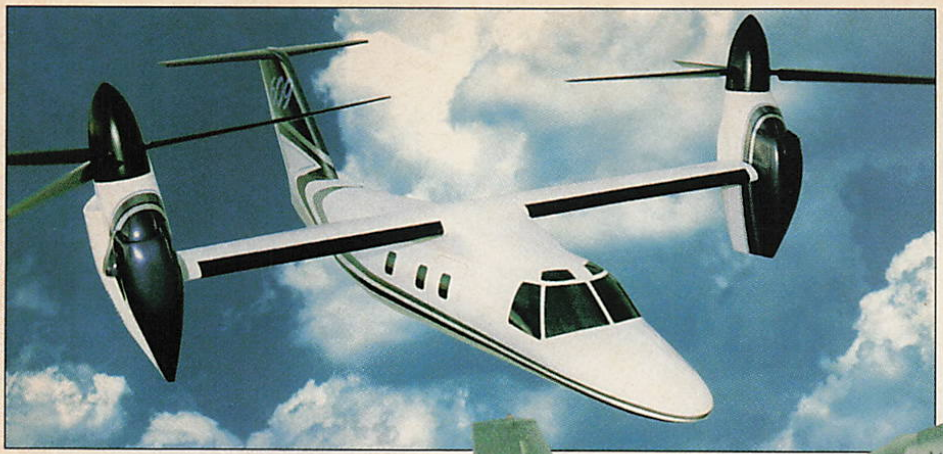


BELL BOEING ILLUSTRATION AND PHOTO

To keep aloft if one engine fails, both the 9-passenger BB-609 (left) and 24-Marine V-22 (below) have a common driveshaft.

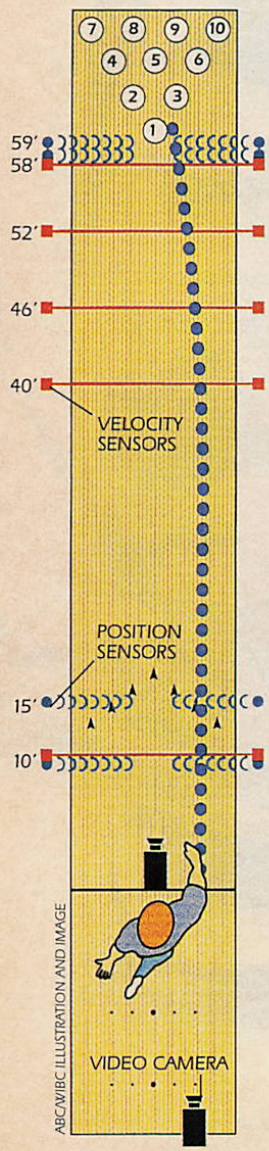
Pint-Size V-22 Is All Business

HURST, TX—If you think that half the battle of going on a business trip is getting to the airport, Bell Boeing's BB-609 civilian tiltrotor could be your kind of airplane.

A smaller version of the V-22 Osprey—which the Marine Corps begins flying in 1999—the BB-609 sports an ungainly pair of wing-tip-mounted 3-blade props. In their horizontal position, the 13-ft. propellers function as rotors. This enables the BB-609 to take off and land on helicopter pads, which can be located just about anywhere.

Once airborne, the mounts holding the Pratt & Whitney Canada 1850-shaft-horsepower PT6 engines tilt forward. In this configuration, the BB-609 looks more like a conventional airplane. And it behaves like one too. Bell Boeing executives say it will transport nine passengers 750 nautical miles at 25,000 ft. and up to 275 knots.

The company estimates that its civilian tiltrotor will shave 30 minutes off the typical 2-hour 25-minute business trip. So far, 29 companies have placed deposits on the $8 to $10 million aircraft. Expect to see the first flying in 2001.



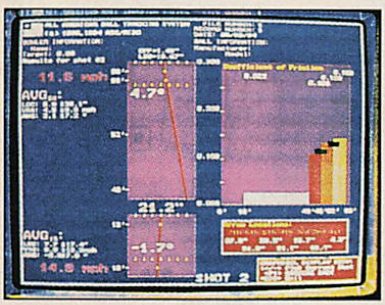
ABC/WIBC ILLUSTRATION AND IMAGE

CATS For Bowlers

GLENDALE, WI—Has your bowling score gone to the dogs? Try playing with CATS.

The Computer Aided Tracking System developed by the American Bowling Congress (ABC) promises to identify the little inconsistencies that trash great games.

"Bowling is a muscle memory sport," CATS inventor Larry Vezina told PM when we gave his system a try at an ABC test lane. "You want to repeat the same thing over and over. Consistency is important."

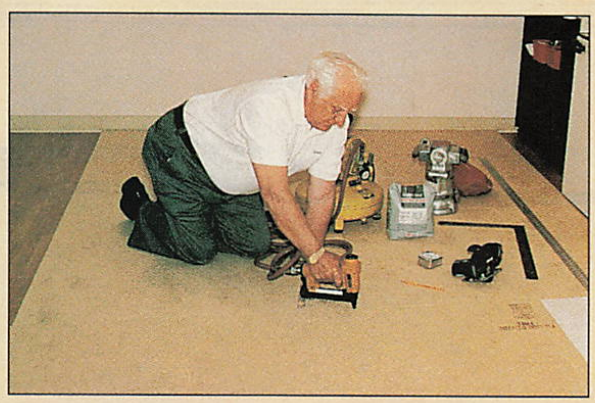


CATS sensors monitor a bowler's performance and the motion characteristics of the bowling ball as it travels toward pins.

As we bowled a series of 40 shots, CATS used a combination of video cameras and position and velocity sensors to watch and—with humbling accuracy—record what we did wrong, which in our case was plenty.

In the hands of a knowledgeable coach, the information gleaned by a CATS evaluation can help a bowler quickly correct the problems that are chipping away at his score. Vezina believes most bowlers—there are 53 million in the United States—could improve their score by 20 points.

After collecting more data using its test system, ABC hopes to market permanent and portable versions of CATS for public lanes.



Straw Houses Return

EGAN, MN—Despite what the three little pigs might think, straw houses really do have a future.

Carpenters say the straw underlayment cuts and fastens like conventional particleboard.

Straw, chaff and residue collected from wheat fields after harvests are now being converted into flooring underlayment using a formaldehyde-free manufacturing process. Developer Naturall Fibre Board says the underlayment, which is marketed as SureFoot, exceeds ANSI testing requirements and has the HUD and FHA approvals that are required by housing lenders.

This piqued the curiosity of Michael Jantsch, an architect in Kansas City, Missouri, who ran a series of tests. "We found that it is very water-resistant, light and flexible," he told PM. "The edges resist chipping out and breaking, and it holds wood screws extremely well."

But the big advantage, says Jantsch, has nothing to do with its technical characteristics. "Our clients who are concerned with environmental issues are pleased to have a renewable source that is environment-friendly," he said.

MCKEE ENTERPRISES PHOTO

(More Tech Update on page 28)

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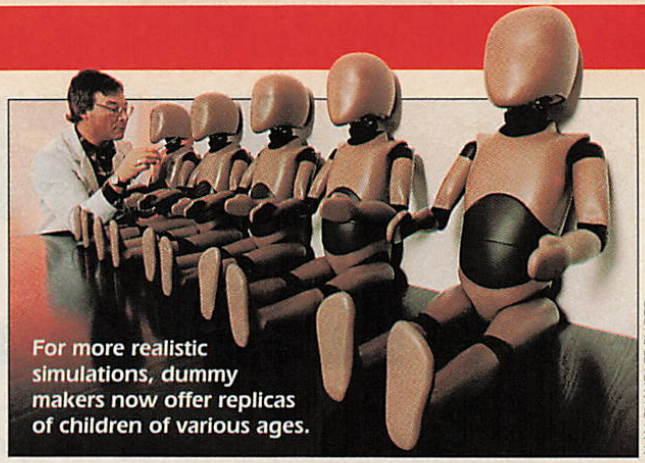
Brains For Crash Dummies

FARNBOROUGH, ENGLAND—Once-secret Cold War submarine research is helping to create "smarter" automobile crash dummies.

To learn more about how the brain reacts in accidents, scientists at Britain's Defence Evaluation and Research Agency (DERA) are filling the heads of crash dummies with a special jelly that duplicates the mechanical properties of human brain tissue.

DERA scientists say they learned how to mimic living tissue while researching ways to make coatings that absorb sonar for Britain's submarines. Ultraprecise sensors embedded within and around this mock brain provide otherwise unobtainable data on the propagation of shear and compression waves that are created by sudden blows.

Understanding the precise way that the brain responds during and after impacts could help save as many as 100,000 lives and minimize the disabling injuries suffered by another 90,000 worldwide each year.



For more realistic simulations, dummy makers now offer replicas of children of various ages.

ALAN CHANDLER PHOTO

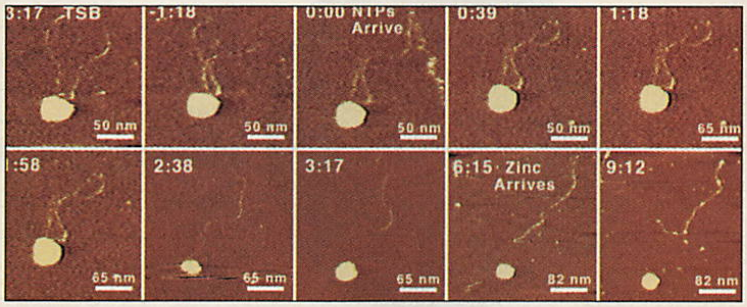
Photos Show DNA At Work

SANTA BARBARA, CA—A new molecule-imaging technique has enabled scientists to look at DNA in action.

To see a cell's genetic blueprint, they employed an atomic force microscope (AFM). Using a process that is similar to forming a mental image of a coin by running your finger over its surface, an AFM drags a stylus with an atom-scale tip over a DNA sample.

To observe the action, Bettye Smith and Neil Thomson and their colleagues in Paul Hansma's lab at University of California Santa Barbara concocted a liquid that contained all but one of the ingredients needed to assemble a protein. The DNA began to assemble the protein, then stopped when it couldn't find the missing ingredient. It restarted when the missing compound was added.

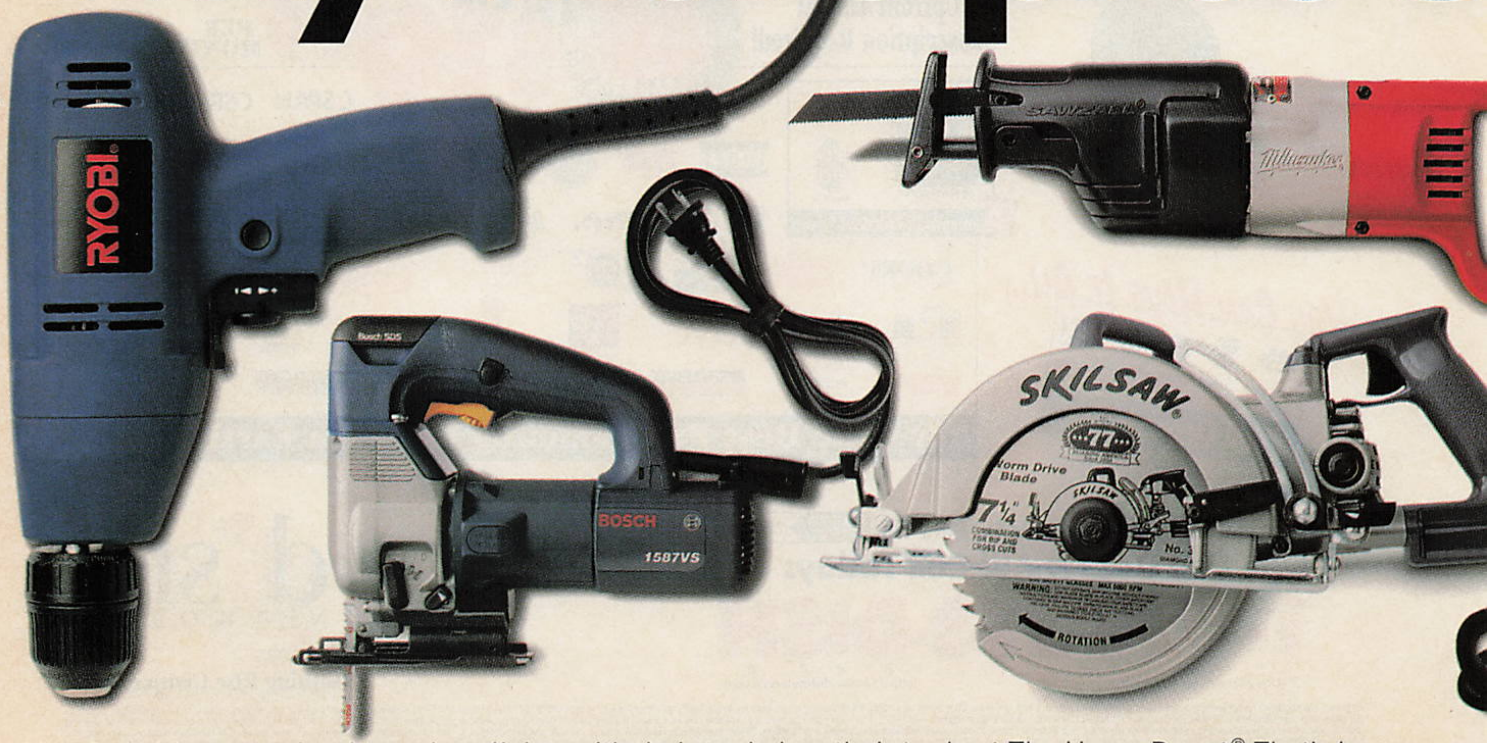
The scientists believe that the ability to image and move individual molecules will create an entirely new field of biophysical research.



Enzyme (white blob) shown copying and then releasing DNA strand.

BIOCHEMISTRY/S. KASAS, N. THOMSON, B.L.SMITH PHOTOS

Why more pros b



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Copy Fluid Attacks Potholes

WACO, TX—Highway engineers think they have a new weapon in the war on potholes: waste toner fluid from office copy machines and printers.

Adding toner, which is approximately 85% styrene polymer and 5 to 15% carbon black, improves asphalt's high-temperature properties and increases its strength and resilience, says Rakesh Tripathi, a Texas Department of Transportation engineer. In theory, this could mean fewer potholes.

To see if the idea works, highway crews recently mixed 61,000 pounds of toner with asphalt. This material was then applied to a 1.4-mile stretch of road here. Engineers are now watching the special pavement to see how well it holds up.

If this field test is successful, the specifications for toner-enhanced asphalt will be given to other highway departments. "We hope that this is something that will be duplicated around the world," Tripathi deadpanned.

Copiers and printers annually produce 30 tons of toner waste, which landfills charge $70 a ton to bury, says Tripathi.

WACO TRIBUNE-HERALD/ROD AYDELOTTE PHOTO

DC Scooters Charge Paris

PARIS—The high-pitch whine of scooters that use gasoline may soon disappear from streets here and in other pollution-plagued cities.

Peugeot Motorcycles and STIQ have teamed up with the French national electricity board and insurance companies to promote a switch to battery-powered scooters.

It shouldn't be too hard a sell. Transportation officials estimate that battery-powered vehicles could meet the travel needs of as many as 94% of current 2-wheel motorists, who typically travel fewer than 37 miles per day. Makers of the new Peugeot ScootElec and STIQ Barigo say they can fulfill these requirements with about 35 cents worth of electricity. However, drivers must remain at speeds below the 28-mph limit.

To make the switch from gas to electric more attractive, the country's insurance companies have promised to offer lower premiums for battery-powered scooters.

The lead-acid batteries used in the new electric scooters can be recharged in 2 to 5 hours.

FRENCH TECHNOLOGY PRESS OFFICE PHOTO

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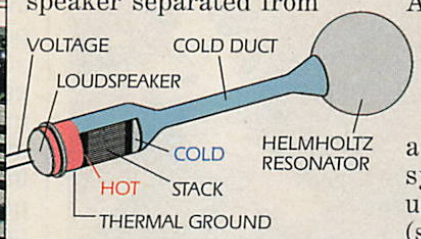
Room-Chilling Sounds

PURDUE NEWS SERVICE ILLUSTRATION AND PHOTO BY DAVID UMBERGER

Mechanical engineering doctoral student Minner (left) and Professor Luc Mongeau (right) test the TRD in their Purdue lab.

WEST LAFAYETTE, IN—Researchers at Purdue University have found a way to cool air with a loudspeaker.

Their 2-ft.-long thermoacoustic refrigeration device (TRD) consists of a loudspeaker separated from



a cavity called a Helmholtz resonator by a tube.

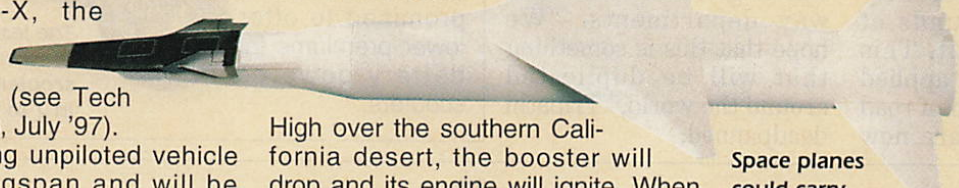
Playing a 300-cycle tone through the speaker causes gas atoms inside the TRD to vibrate, thus setting up pressure fluctuations. "When you compress a gas, it becomes warmer, and when you decompress it, it becomes cooler," explains student Brian Minner, who developed the device with his professor. A porous transfer stack in the center pumps the heat toward the speaker, thus cooling its opposite end.

Acoustic cooling is not a new idea. A large-scale system is currently being used to liquefy natural gas (see Tech Update, page 32, May '97). The device interests appliance makers because of its smaller size, which offers a way to build Freon-free refrigerators and air conditioners.

Hyper-X Countdown Begins

EDWARDS, CA—Researchers at the Dryden Flight Research Center have begun preparations for the 1999 flight of the Hyper-X, the world's first air-breathing hypersonic vehicle (see Tech Update, page 18, July '97).

The 12-ft.-long unpiloted vehicle has a 5-ft. wingspan and will be attached to the nose of an Orbital Sciences booster rocket that will be mounted beneath the wing of a specially equipped B-52 bomber.



NASA/BRENT WOOD PHOTO

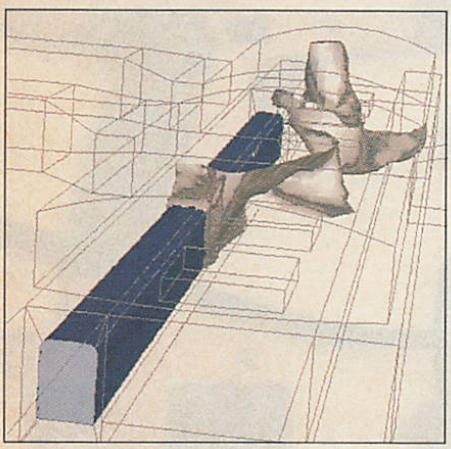
Space planes could carry more payload than rockets.

High over the southern California desert, the booster will drop and its engine will ignite. When the booster's fuel is expended, the Hyper-X will break away, fire up its supersonic-combustion scramjet engine and, under its own power, fly to 100,000 ft. at speeds of Mach 5, 7 or 10, depending on the flight plan.

"We are ready to be the first to fly an air-breathing vehicle at hypersonic speeds," said Vince Rausch, NASA's Hyper-X project manager.

3D Software Fights Fires

WATERLOO, CANADA—New software promises to help fight fires in subways, engine rooms and other confined spaces. Called TASCflow, the program creates a 3D model of a fire that it can use to test different containment strategies.



WORCHESTER POLYTECHNICAL INSTITUTE ILLUSTRATION

In this fire simulation, software identifies best location for subway ventilation fans.

At a recent engineering conference, TASCflow developer Advanced Scientific Computing showed PM how a fine mist of water could extinguish a hard-to-fight fire in a ship's engine room.

At first, the mist appeared useless as it evaporated in the hot gases above the flame. The display image, however, revealed that the evaporation was cooling the air and creating a downdraft that was carrying the remaining water to the hottest part of the fire. The blaze was extinguished in 10 seconds, with minimal water damage.

If environmental restrictions on extinguishing agents that harm the ozone layer continue to stiffen, software that analyzes blazes could become as common to firefighters as fire hoses.

Washer Saves Dry Town

BERN, KS—For years, the brie and Chablis set has touted the superior cleaning ability of expensive European front-loading washing machines.

In an odd twist of economics—which illustrates the high cost of "free" well water, among other things—an Americanized version of the luxury washer is being used to alleviate this town's chronic water shortage.

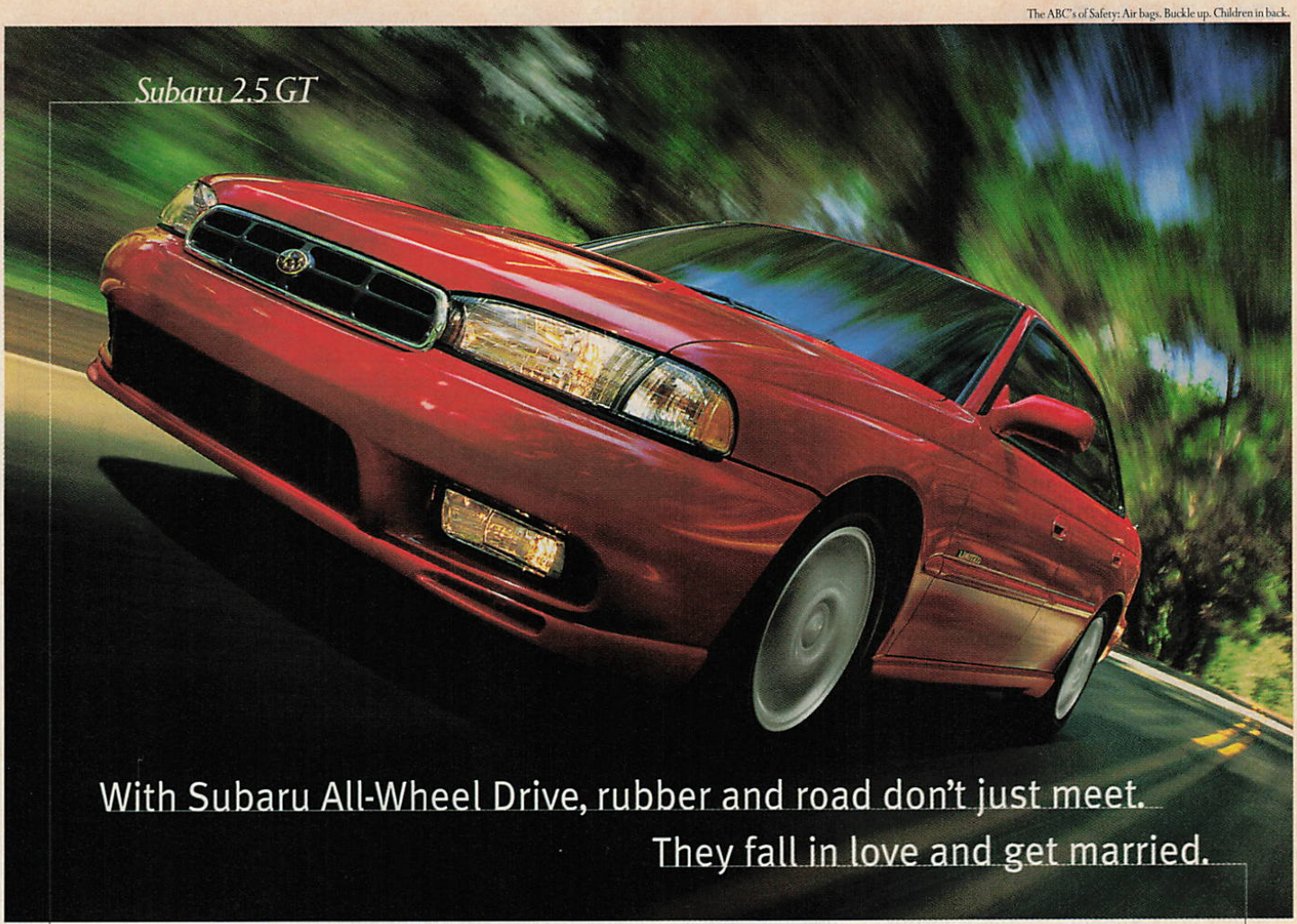
As part of a Department of Energy experiment, 104 Maytag Neptune washers have replaced top-loaders here. The Neptune's front-loading design and other improvements are said to reduce water use by 40%. And by requiring less hot water and extracting more moisture in the spin cycle, they cut per-load energy use by 65%.

Next year, the DOE will issue a report on whether these premium-priced washers—they cost five times as much as low-end top-loaders—could help other parched towns. TU

MAYTAG ILLUSTRATIONS

Tilting saves energy and water, as front-load and top-load (longer) comparison bars show.

The ABC's of Safety: Air bags. Buckle up. Children in back.



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SUBARU

The Beauty of All-Wheel Drive.®

Waterjet Rocket Rides

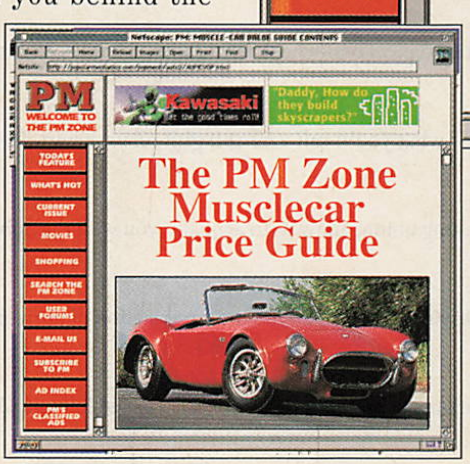
BY CLIFF GROMER, Contributing Editor

● **Navigation:** *Click on the Outdoors button on the PMZone menu. Then click on Boating, and finally click on "Thrust-Propelled Excitement."*

Adventure and adrenaline. That's the Outdoors Department at POPULAR MECHANICS. And that's what you'll find when you click on the Outdoors button on the PMZone. And if you click on Boating, you'll find features that are just a mouse click away. Following is a sample:

"Thrust-Propelled Excitement" puts you on two of the hottest personal watercraft—the Sea-Doo XP and the Kawasaki 100 STX. The former is essentially a high-performance production racer, while the Kawasaki model is a 3-seater sport tourer that can speed up to 50 mph and qualifies as one of the best examples of the breed.

Want even more thrills? Up the ante to 1000 horsepower and more than 70 mph when you click on "Speedboat School" under Boating. This feature puts you behind the wheel of a $156,000 Wellcraft Scarab and gives you an introduction to high-performance speedboat driving.



Live Chats With Our Editors

Navigation: *Click on the User Forums button on the PMZone menu. Then click the Chat button and follow the directions on the screen.*

If you've never chatted live on the Internet, you're missing out on one of the system's really neat communication tools. It's like a big party line, so several readers can communicate with the editors at one time—and also with each other. Of course, you can also chat one-on-one with the editors. Currently we have editors from three departments, as well as Editor-in-Chief Joe Oldham, lined up for live chats.

Don Chaikin, our Automotive Editor, has driven just about everything that's on wheels and loves to talk cars.

Roy Berendsohn, Associate Home Improvement Editor, will discuss remodeling, shop tools and techniques and lawn and garden tips.

Jim Gorant, our Outdoors Editor, is an expert on boats, motors, snowmobiles, personal watercraft as well as outdoor clothing and equipment.

Musclecar Price Guide

Navigation: *Click on the Automotive button on the PMZone menu. Then click on Collector Cars, and finally click on Musclecar Value Guide.*

Musclecars are hot—again. After experiencing price heating and cooling cycles over the past decade, the value of big-cubic-inch, high-horsepower iron produced by Detroit in the mid-1960s through the early '70s is once again on the rise. If you own a musclecar or are in the market for one, you need to check out our Value Guide, a PMZone exclusive. You'll find out what your car is currently worth and what you can expect to pay for the model you're hunting for.

The Guide's condition-rating system relies on a 0-125 point scale that accurately evaluates everything from an unrestored original in poor to fair condition to a fully restored "best of show" beauty.

You'll find hundreds of models classified by make—American Motors, Buick, Chevrolet, Dodge, Ford (including Shelby), Mercury, Pontiac, Oldsmobile and Plymouth. **PM**

LIVE CHATS

Tuesday, Sept. 16, 2 to 4 pm
Joe Oldham, Editor-in-Chief: "POPULAR MECHANICS, The Magazine."

Tuesday, Sept. 23, 2 to 4 pm
Don Chaikin, Automotive Editor: "Cars And Trucks."

Tuesday, Sept. 30, 2 to 4 pm
Jim Gorant, Outdoors Editor: "Boating, Bikes And Fitness."

Thursday, Nov. 13, 2 to 4 pm
Roy Berendsohn, Associate Home Improvement Editor: "Home Improvement And New Products."

All times Eastern. Dates and times may change. Please check the PMZone for the latest information.

PM PHOTOS BY VINCENT IORIO (TOP) AND JERRY HEASLEY (INSET)

LIGHTS: 9 mg. "tar", 0.6 mg. nicotine, FULL FLAVOR: 13 mg. "tar", 0.8 mg. nicotine, FULL FLAVOR MENTHOL: 14 mg. "tar", 0.8 mg. nicotine av. per cigarette by FTC method.

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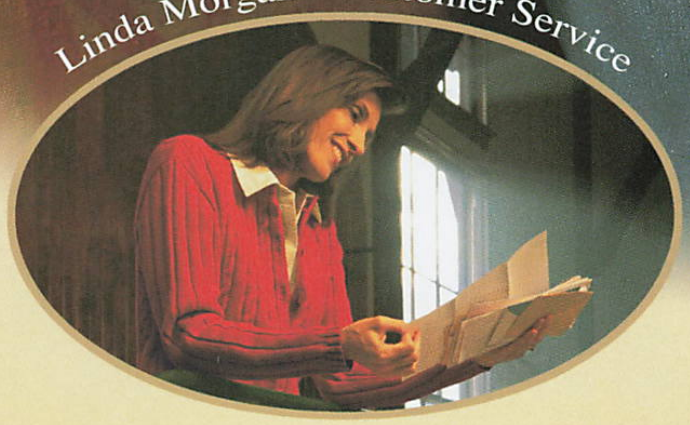

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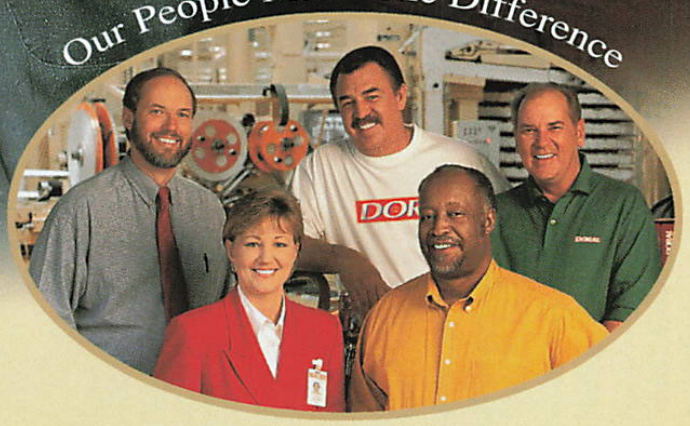

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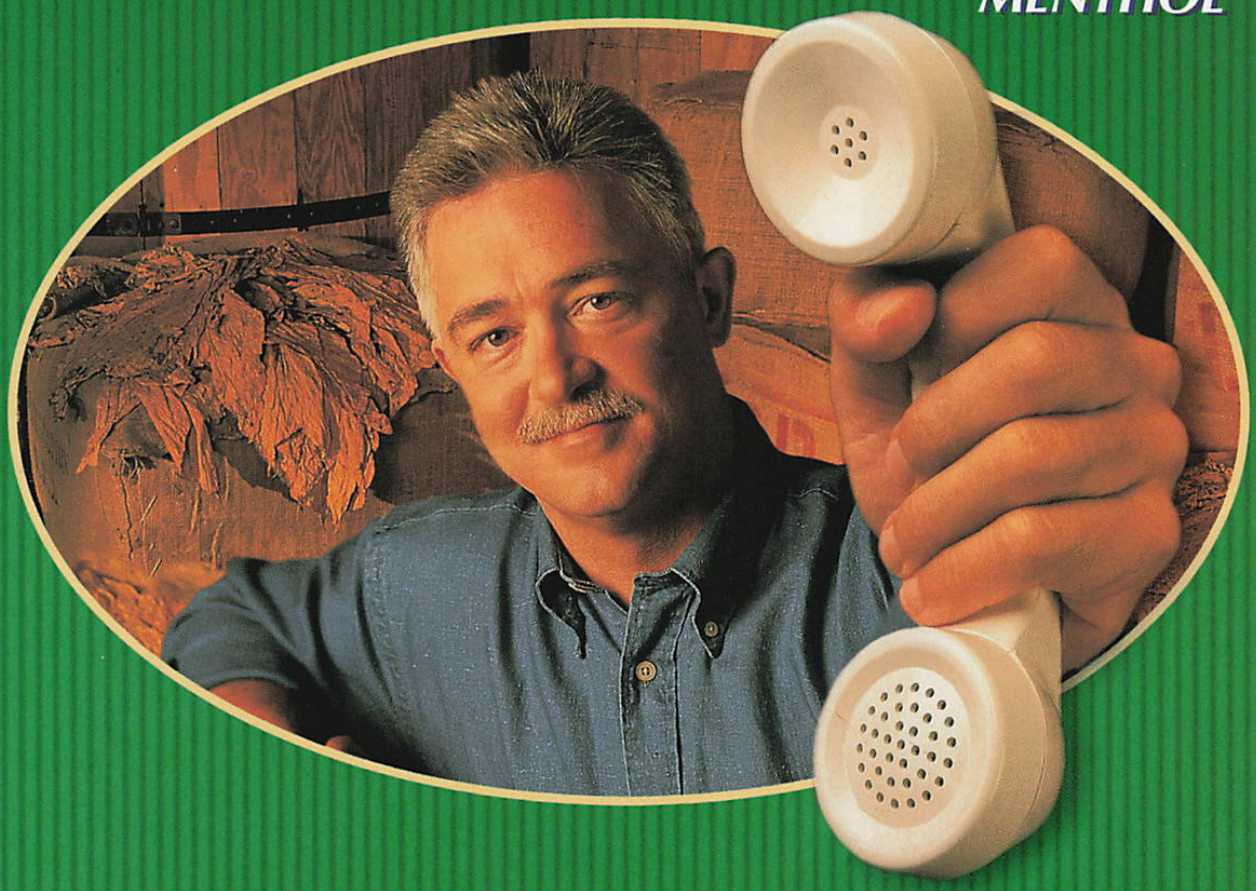

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Think It's New? Think Again!

DVD predates the color TV.

BY MARY SEELHORST

PRESENT ● Digital Video Disc, Digital Versatile Disc or Disillusioned Viewer's Dream? Whatever you call it, DVD, like its predecessor the laser videodisc, puts video data on a platter. But while a videodisc's visual data is analog, a DVD contains entirely digital information.

Although DVD has yet to rewind the videocassette business, it is a promising new format. Its digital nature opens new video possibilities, such as faster searching, widescreen viewing, up to 32 subtitle tracks and multiple audio tracks for providing language choices.

And don't overlook the obvious. The simple fact that discs are round means that random access is possible. This holds true for videodiscs, DVDs, CDs or LPs. (Remember dropping the needle in the middle of a song?) Not only are winding and rewinding forever eliminated, but you can seamlessly switch to any place on a DVD. With the capability to hold many hours of video, DVD could provide viewers with several endings to a movie or choices between several camera angles for a sporting event.

But after you read this, you may decide that DVD should really stand for Déjà Vu Disc.

PAST Video on a platter. Think it's new? Think again! POPULAR MECHANICS presented an analog precursor to DVD back in 1941. "Motion Pictures Made on Phonograph Records" was the headline. A technique developed for transmitting movies across phone lines or by radio also offered the possibility of reproducing movies on records instead of film.

"The movie images are transformed into vibrations that are then recorded on a disc, just as sound vibrations are recorded," PM reported. To play the disc, you needed a high-frequency pickup and a circuit that played the moving image on a cathode ray tube—basically like those used in television.

And there were other possibilities proposed for movies on records in 1941. The round shape of the medium allowed for a kind of movie jukebox, showing short films in exchange for the deposit of a coin. (The phrase "pay-per-view" hadn't been invented yet.)

The fact that LP movies didn't catch on isn't that much of a surprise once you crunch the numbers. Today, a DVD can store enough data for up to 8 hours of studio-quality audio and video on a 4.75-in. disc. In 1941, the big 10-in. platter played back at 100 rpm to reproduce just over 1 minute of motion picture and audio. Let's see, at that rate you'd have to have 121 platters to play back "Star Wars," or 378 for the whole trilogy, give or take a few. And, let's not forget that you would be watching all this in black and white.

Others also attempted to encode video data on a record platter. Beginning in 1965, RCA researched several kinds of videodiscs. One of them used an electromechanical needle in a groove, just like a record. Another used a laser to read the data, but RCA rejected that idea—after all, lasers had never been used in a home appliance. By the time RCA released its Selectavision VideoDisc in 1981, videotape had already taken a bite out of the middle market, and Philips had captured the high-end videodisc market with the now-familiar laser system.

As you sit back with your DVD remote, think about the following facts. A digital videodisc is made of foil encased in plastic, with the data stored as a series of pits in a spiral. Think it's new? Think again! Edison's first phonograph was a piece of tinfoil wrapped around a cylinder, with the data recorded as a tiny groove in a spiral. And Edison's 1888 analogy for a moving picture machine was a phonograph for pictures. What goes around comes around. And around, and around, and around and around. **PM**

December 1941

Motion Pictures Made on Phonograph Records

Upper left, scanner transforms movie image into ir
pulses for recording on vision-and-sound disk, show
below. Right, coin machine playing sound movie di

movie images are transformed into vibra
tions that are then recorded on a dis
just as sound vibrations are recorded; th
record then may be played back throug
a television-type circuit, using a high
frequency pickup and a cathode ray tub
to reproduce the original film. The trans
mitted image can be enlarged to an 18
by-24-inch screen. To prevent flicke
several parts of each frame are scanne
simultaneously. At the present stage
development, a ten-inch disk at 100 rev
olutions per minute produces a fractio
above a minute of screen vision. A soun
track on the same disk is synchronized
produce the picture's sound accompan
ment. Backers of the "radio vision" ma
chines look forward to ultimate full theate
projectio the movie records, and

Translating light into sound and sound into electrical waves, engineers have suc-

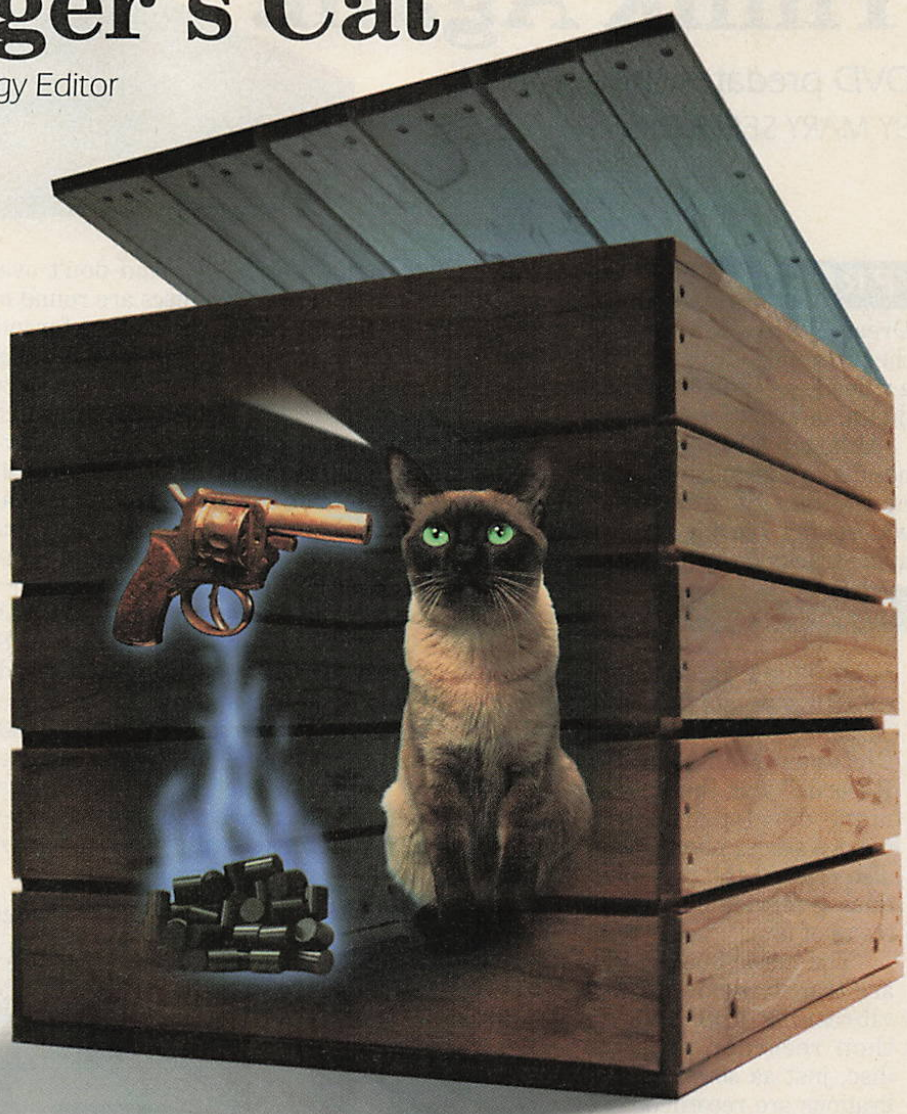
As phonograph record manufacturing matured, engineers explored uses other than music.

PM PHOTO BY MICHEL TCHEREVKOFF (TOP)

SCIENCE

Executing Schrödinger's Cat

BY JIM WILSON, Science/Technology Editor



PM PHOTO ILLUSTRATION BY EFRAT ZALISHNICK

● Researchers believe they will soon be able to solve one of the most perplexing problems of modern physics: finding a way to execute Schrödinger's cat.

The imaginary feline has been dogging scientists since 1935. No doubt to the horror of cat-lovers everywhere, in that year an experiment using a cat to illustrate the dilemma of quantum theory was presented by Erwin Schrödinger, an Austrian-born physicist and one of quantum theory's founding fathers. Frequently described as the most successful scientific theory of the 20th century—without it we wouldn't have lasers, gene splicing or nuclear weapons, among other things—quantum mechanics explains how nature operates at the subatomic level. Here, the familiar rules of everyday living specified by classical physics no longer apply. A subatomic particle can be in two places at once. Information appears to move faster than the speed of light.

The rules that govern the quantum realm are so strange that Albert Einstein is reported to have thrown up his hands in dismay and remarked, "If quantum physics is correct, then the world is crazy." Even Schrödinger was unhappy with the implication of his findings. "I'm sorry that I ever had anything to do with quantum theory," he is said to have lamented to a colleague.

The problem that perplexed Einstein, Schrödinger and generations of physicists after them has to do with reality. According to quantum theory, particles can come into existence only when they are "observed." Our everyday experiences teach us that this is nonsense.

Initially, Schrödinger's description of the wave function—a mathematical expression that summarizes a particle's possible positions and movements—contributed to the riddle's conception. Nine years later, he created his cat experiment in order to illustrate the dilemma of bridging the gap between quantum- and human-scale reality that he had helped to create. In his "thought experiment," also called an imaginary experiment, he envisioned a cat placed inside a closed box along with a hair-trigger execution device and a radioactive atom. The atom had a 50% chance of decaying within 1 hour. If the atom decayed, the subsequent energy release would trigger the device. After waiting exactly 1 hour, anyone opening the box could expect to find the cat dead or alive.

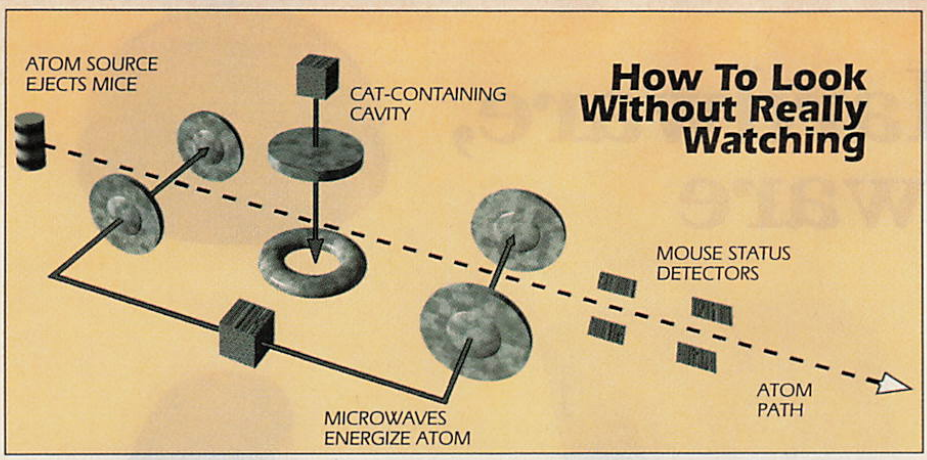
Not so fast, said Schrödinger. According to the rules of quantum mechanics, the cat existed in a dead-and-alive state—known formally as a quantum superposition—until someone lifted the lid and made an observation. This contradiction of the way the world works at the human-scale level may seem foolish. But, as Schrödinger pointed out, the superposition was required by the mathematics that gave quantum theory its ability to perfectly predict the way the world works at the subatomic level.

And so, for more than half a century, Schrödinger's dead-and-alive cat has been clawing at the ankles of physicists, demanding to know exactly how the quantum realm connects with the human-scale world.

A perplexed and impatient layperson could exclaim, "This is ridiculous! Just open the damn box and see if the cat's toast or not!" But physicists believe that doing this would be inconclusive because, according to the rules of quantum mechanics, the act of observation would cause the cat to jump into either its dead or alive state.

Last spring, a team at the École Normale Superieure (ENS), in Paris, took a major step toward reconciling the human-scale, or macroscale, realm with quantum-scale systems. They proposed a way to sneak a peek at the cat without lifting the lid on the box. They planned to march the subatomic equivalent of a mouse past the cat's nose and see what happened.

DEPARTMENT OF ENERGY PHOTO (PELLETS); ANIMALS, ANIMALS/MICHAEL AND BARBARA REED PHOTO (CAT); STOCK MARKET/J. BARRY O'ROURKE PHOTO (GUN)



The ENS team uses atom "mice" to see if an electromagnetic Schrödinger's cat is both dead and alive. Results are inconclusive, but suggest the quantum realm is accessible.

The cat and mouse proposed by the ENS team are actually atoms (see illustration above). The box in which the cat is trapped consists of centimeter-sized cavities created by superconducting mirrors. To start the experiment, an atom passes through a field of microwave-frequency energy. In effect, it puts the cat in the box. A second atom follows, playing the part of the mouse. The way in which this second "mouse" atom is changed by its passage through the cat-containing cavity indicates the state of the quantum superposition.

So far, it's too early to tell much about what's happening inside the box. Preliminary findings by the ENS team suggest that the dead-and-alive state required by the rules of quantum theory exists for only a very brief time. The ENS team suggests that this could explain why large objects are never found in anything other than their familiar form. So perhaps Schrödinger's cat has finally been put to rest—executed if you will.

A device capable of probing the dead-and-alive state of Schrödinger's cat is of more than academic interest. Bridging the gap between the quantum- and human-scale realms will help in the development of a new generation of electronic, computer and communications security devices.

In June, physicists at the University of Geneva performed an experiment that suggested it may be possible to tap the quantum realm to solve a pressing modern problem—keeping financial data secure as it travels over telecommunications networks.

The theoretical basis for tapping the quantum realm for a security device was raised long before anyone was talking about electronic commerce. In the 1920s, Schrödinger realized that quantum theory made it possible to create a pair of photons—indivisible packets of electromagnetic energy—that were "entangled" in such a way that each would immediately know its partner's fate.

The word "immediately" troubled Einstein because it implied that signaling was taking place at faster-than-light speeds. Einstein summarily dismissed this possibility as "spooky actions at a distance."

For lack of subtle testing equipment, the issue remained at an impasse until 1982. Then, Alain Aspect, also of ENS, measured changes in pairs of entangled photons about a football field apart. When quantum theorists looked at Aspect's work, they suggested he might have observed a localized effect that diminished over distance.

To determine just how far Einstein's "spooky actions at a distance" extended, Dr. Nicolas Gisin and his colleagues at the University of Geneva earlier this year arranged to place a very unusual phone call over Swiss Telecom fiberoptic phone lines.

They created pairs of entangled photons in their Geneva laboratory. Each pair was then split so that one photon traveled north to the village of Bellevue while its companion traveled south to Bernex, a total distance of about 7 miles. The EMS team placed a signal analyzer at each end of the line. As a photon passed through an analyzer, it had a random chance of being counted. When the data from the two analyzers was later evaluated, there was compelling statistical evidence that a photon "knew" whether its entangled companion had been counted.

Researchers don't believe the quantum realm could be tapped as a medium for faster-than-light-speed communications. But in light of the Swiss experiment—the details of which have not yet been published in the scientific literature—some suggest such a signaling system could be used to reveal whether data had been viewed by unauthorized eyes.

If such an encryption system becomes a reality, Schrödinger's cat could be reborn and find a new career sniffing out rats online. PM

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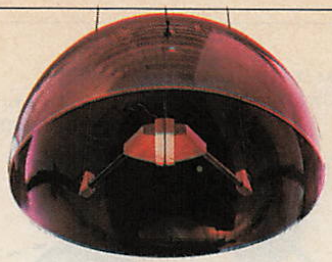
E3: Hot Hardware, Cool Software

BY JONATHAN GROMER

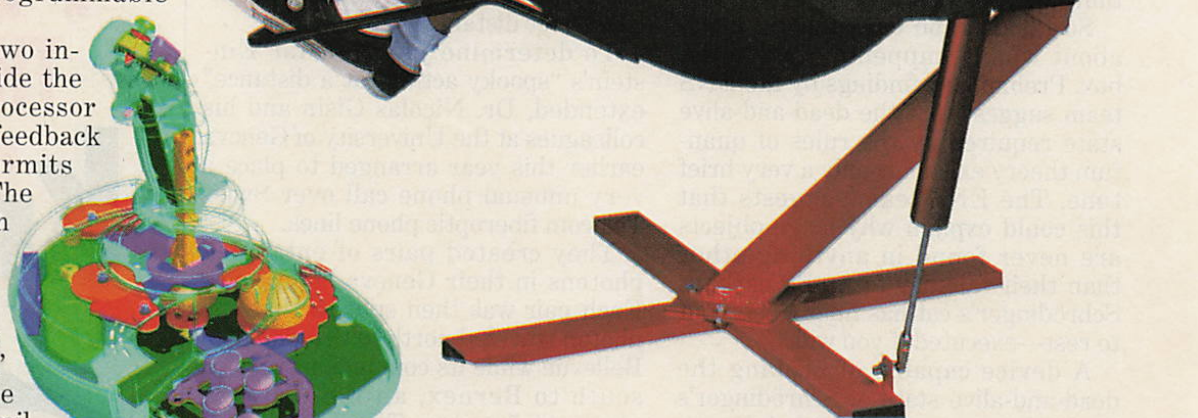


• The E3 Show (Electronics Entertainment Expo) is a mecca for software manufacturers itching to show off their new products' cutting-edge sound, graphics and network capabilities. And it's not only software.

Microsoft's new Sidewinder Force Feedback Pro joystick takes force feedback to a higher level. Even though it wasn't available in stores at the time of the show, it already had 20 new titles waiting for it. New sensations you'll experience include actually feeling your race car rumbling on the starting line, the kick from a handgun and several other programmable sensations.

The joystick uses two internal motors to provide the feedback. A 16-bit processor handles all the force feedback computations and permits multilayered forces. The price is $149.95, which includes three games.

If you're prone to motion sickness, you might want to skip this next item. The Rock 'n' Ride is *the* first home flight simulator chair available for the PC. Powered by a small air compressor and two pneumatic actuators, the chair will mirror the direction, force and pitch of all your joystick movements up to 60°.



Gaming is more realistic with an affordable flight simulator chair, new-generation 3D sound, 3D graphics and 16-bit force feedback joystick.

Your monitor attaches to a metal arm extending off the seat, and it helps keep the chair in perfect balance. The 75-pound chair costs only $799 with the air compressor, $699 without. It takes about 2 hours to assemble and is ready to go as soon as you plug it into the existing joystick port of your Mac or PC (your joystick plugs into the chair). If you're a PlayStation or Nintendo 64 owner, don't have an anxiety attack. A $45 converter will be made available. The package is available from Rock 'n' Ride; 888-431-9893; http://www.rocknride.com.

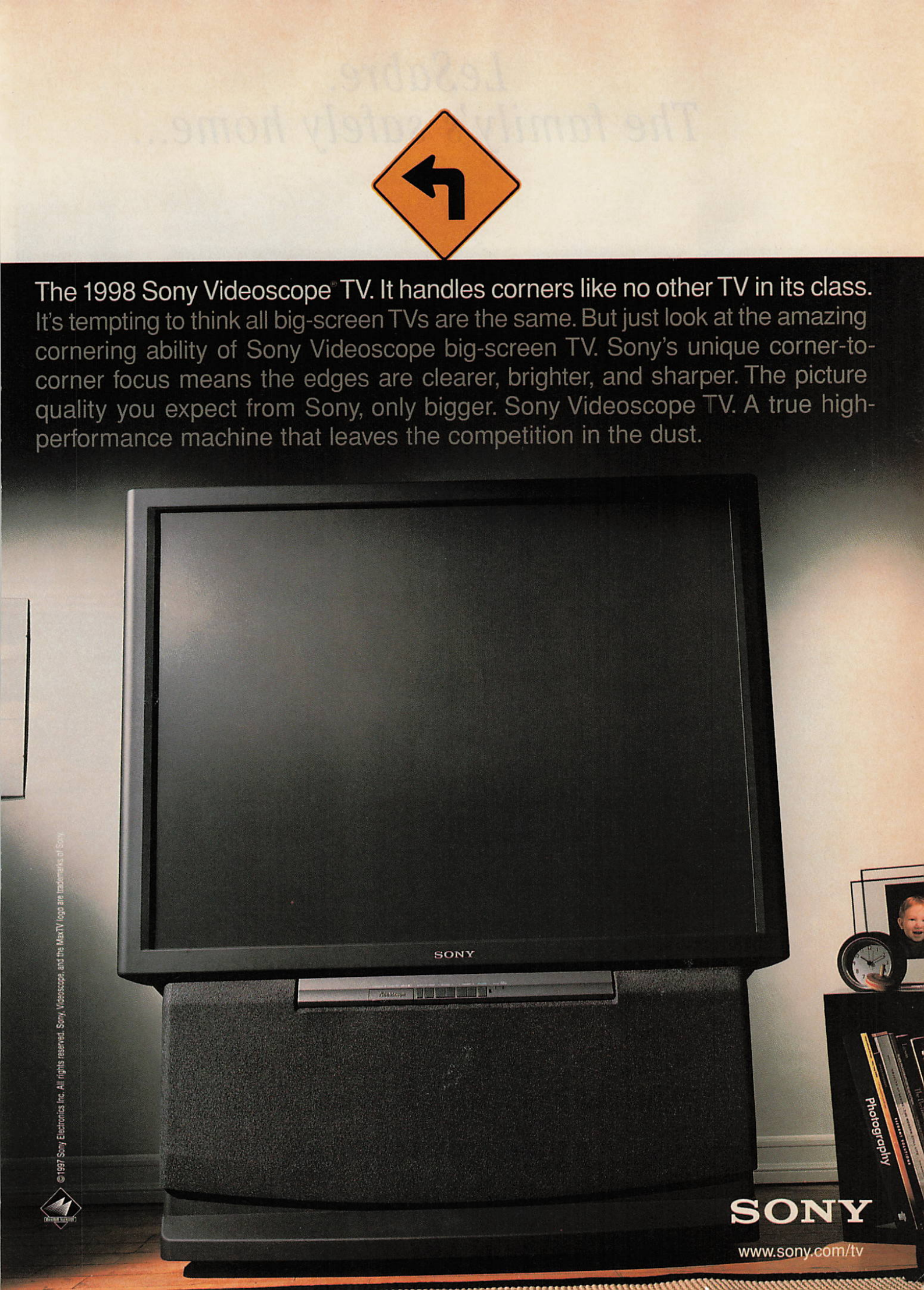
3D sound—surround-like sound from just two speakers—also reaches new levels of realism. Brown Innovations' Virtual Audio Imager is a new approach—a dome that mounts above your head to create a 3D listening area. Outside of this area the sound level drops 80% (14 to 16 dBA), so the family won't wake up when you're blowing away bad guys in "Quake" at 3 am. If you're using the Localizer Companion amp, you'll get a frequency response of 150 Hz to 20 kHz, plus or minus 2 dBA—unbelievably flat. The dome costs $799 from Brown Innovations; 773/296-8400; http://www.purestereo.com.

The final element that will transform gaming as we know it is 3D video. Yeah, 3D glasses stink. They're huge, corded and have very little software support, and they give you a headache if you use them for more than an hour. Throw 'em in the trash can and pick up the new lightweight, cordless shades from H3D entertainment.

The extensive planned software support starts with a patch for stereo "Quake" coming out this fall from id Software, plus a couple of movies, with more to follow.

Eyestrain and headaches have been eliminated by preventing the screen from dropping below the frequency at which a person perceives a flickering light. You get the glasses, an IR transmitter and a game for less than $100. Or if you want to start off with the TV package, you get the glasses, a transmitter and a movie for the same price. Extra glasses are $25 each and everything is available through H3D directly. Contact H3D; 800-H3D-2155; http://www.h3dentertainment.com. PM

PM PHOTO (TOP LEFT) BY CLIFF GROMER


The 1998 Sony Videoscope® TV. It handles corners like no other TV in its class.
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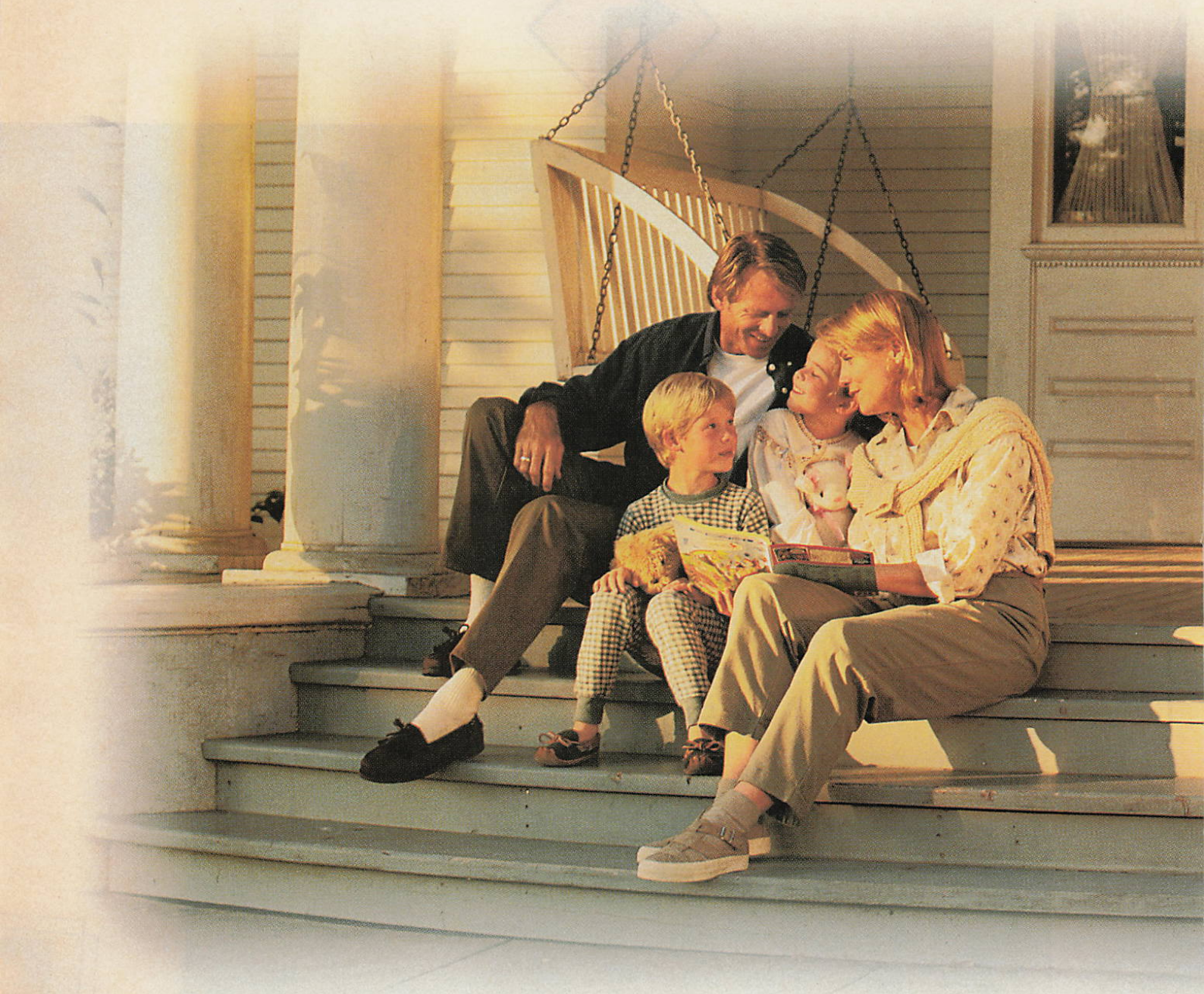

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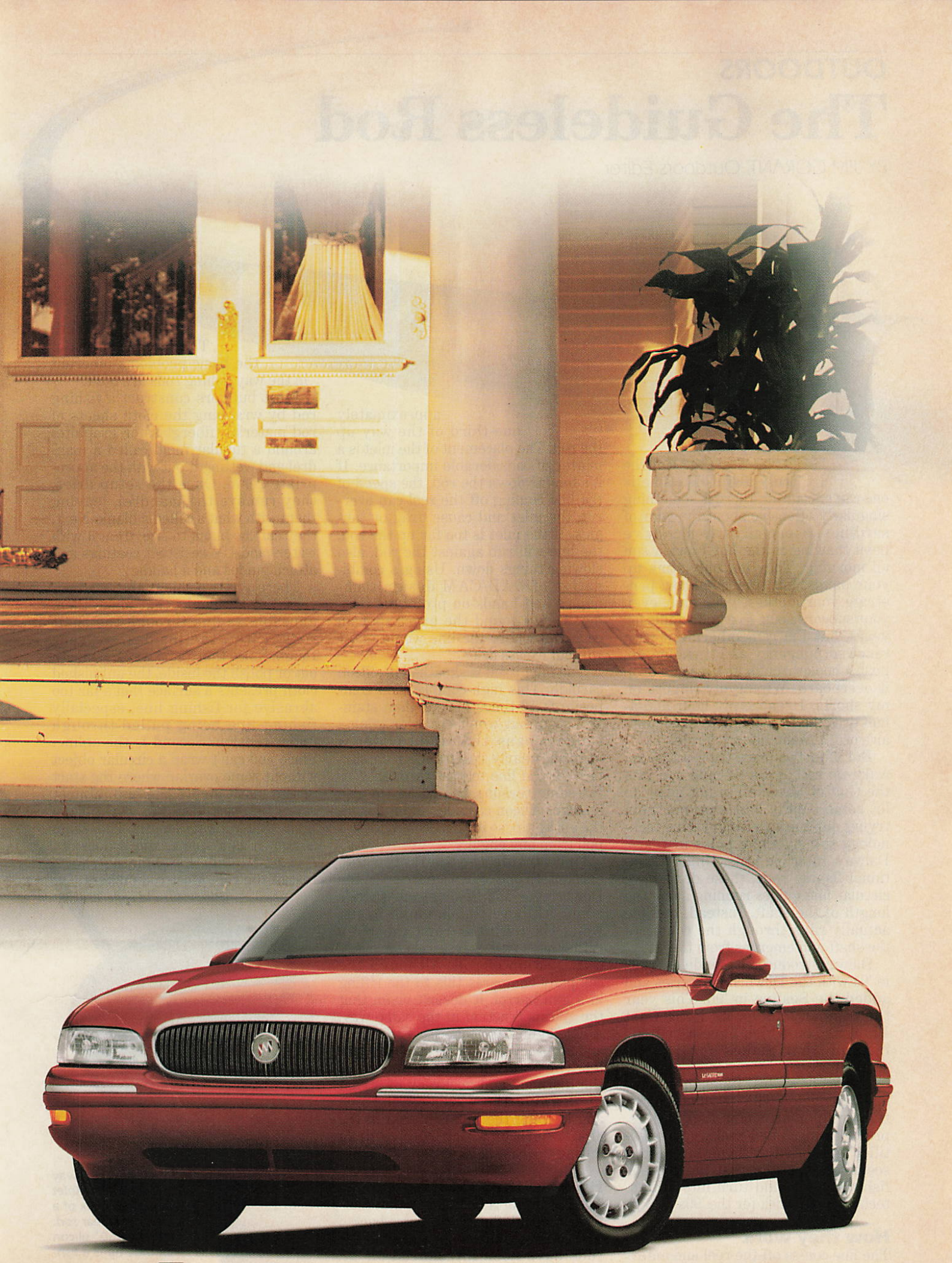

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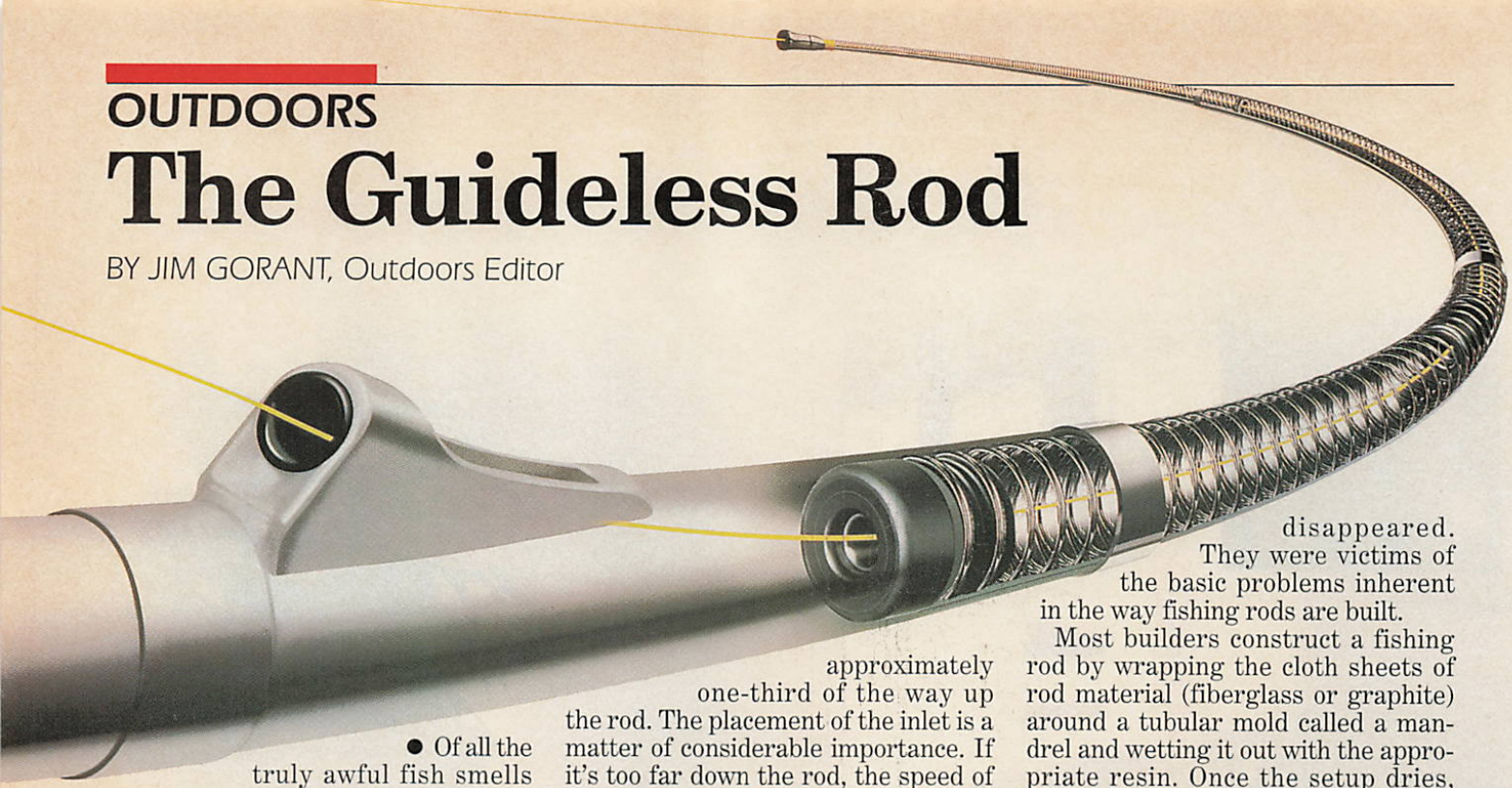
The Guideless Rod

BY JIM GORANT, Outdoors Editor



● Of all the truly awful fish smells one can encounter, there is something singularly offensive about the odor of sardines, especially when they've been thawing in the hot Florida sun all morning. They not only stink up your hands, but they somehow penetrate your clothes, your hair, even your subconscious. I've known this for years, but I'm remembering it with renewed pungency as I pick one up, push a hook through its eyes and drop it overboard. Wiping my fingers on my shorts, I realize my hour-and-a-half drive home is going to make Jonah's ordeal seem like a joy ride.

But after two plane trips, a 5:30 am wake-up call and a 24-mile run into the Gulf of Mexico, I'm not going to let some smelly bait stop me from trying out the most innovative technology to hit fishing poles in years: Daiwa's Interline rods. Unlike traditional fishing rods, these don't have circular line guides running along the length of the shaft. Instead, the line actually runs through the center of the shaft and emerges from the tip.

Daiwa introduced its guideless rods in '94 with the Downrigger series and added the Sealine in '96. This year the company added its Long Cast Linear rods, which have a "rifled" interior that makes for longer, straighter casts.

In recent years, fishermen have been inundated with satellite navigation equipment, sonar fish finders, precision-machined reels, and scientifically scented artificial lures, so it seems only natural that the good ol' fishin' pole should turn into a high-tech whippin' stick for the '90s.

How they work

The line comes off the reel and enters the rod through a line inlet located approximately one-third of the way up the rod. The placement of the inlet is a matter of considerable importance. If it's too far down the rod, the speed of the line coming off the reel can overrun the inlet and cause drag or tangles. If the inlet is too far up the rod, the line will rub against the rod, also slowing things down. Using a combination of CAD/CAM design techniques and hands-on prototype testing, Daiwa found the exact spot on each rod where the line would enter without excess drag.

The inlet itself is sheathed in silicon carbide. This high-compression composite is 12 times harder than stainless steel but won't crack or gouge, which means that it provides a smooth, nearly resistance-free surface for the line to pass through. For the same reasons, the outlet tip also features silicon carbide, and it covers the entire tip, so it can accommodate a pull from any angle.

Once inside the shaft, the line encounters one of two surfaces: In the Downrigger and Sealine rods there's a smooth-bore finish, while in the Long Cast Linear rods there's a raised helix with 200 spirals for every 6-ft. section of rod. Although the company compares this to the rifling in a gun barrel, it doesn't claim that the spirals function in the same way. A rifled gun barrel increases distance and accuracy by putting spin on a bullet. The Interline's rifling increases the distance and accuracy of a cast by drawing the water off the line and keeping the line centered in the shaft, both of which reduce drag during the cast.

How do they do it?

The patent for a fishing rod that has a line through the middle dates back to the 1930s. Since then, three such rods have been introduced on the market, but all three quickly disappeared. They were victims of the basic problems inherent in the way fishing rods are built.

Most builders construct a fishing rod by wrapping the cloth sheets of rod material (fiberglass or graphite) around a tubular mold called a mandrel and wetting it out with the appropriate resin. Once the setup dries, they remove the mandrel, leaving them with what's called a blank. Next, they cut the blank to size, treat it with water- and UV-resistant coatings and attach guides and a handle.

There are two things that are universal to all blanks that make them unusable as line-through-the-shaft rods. First, the insides are very rough. Since there's no way to smooth out or polish the inside, the unfinished cloth presents a surface that's far too abrasive for fishing line, especially fishing line being pulled through under tension. Second is the spline. Since you can't wrap a circular object without some overlap where the start of the cloth meets the end, almost every fishing rod in the world has a seam that runs its length. This seam is known as a spline, and it doesn't flex and bend the same as the rest of the rod. Most rod makers

(Please turn to page 42)

Top: A cutaway shows line inlet and raised helix of a Long Cast Linear rod. Left: The 360° silicon carbide tip is a fish-fighting advantage.

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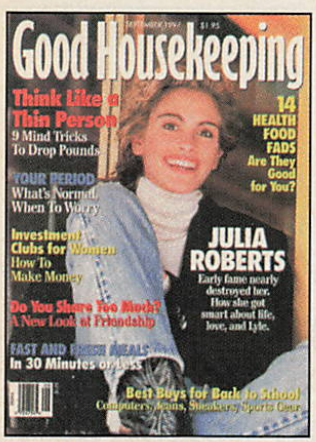
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believe that the guides must sit exactly opposite the spline in order for the rod to work properly.

The Interline rods somehow have a completely smooth interior, sometimes lined with an extremely precise helix, and they have no spline. How Daiwa does it is still a mystery. Some companies have tried putting a liner inside a blank to make a through-the-blank rod, but this 2-piece approach usually leads to a bonding problem. Still, a liner doesn't eliminate the spline, and an Interline is one piece, anyway. While Daiwa waits for approval on its patent applications, the company remains silent about its construction methods.

Analysis

There are disadvantages to the Interlines, though. In order to string them, you have to use a special rigging cable that leads the line in through the inlet and out the tip. The cable is small and fairly easy to use but probably a little more cumbersome and time-consuming than the old method. Also, there will be some increased drag as a result of the inlet, although how much and if it makes a difference is unclear.

Against that there are some noteworthy structural and performance benefits—on paper anyway. Say you have a 7-ft.-long rod with seven guides on it. When you have a fish on, the rod bends into a perfect arc, but the line only imitates that arc in an imperfect series of straight lines running from guide to guide, creating seven stress points. This uneven distribution of stress can cause the rod to twist and bind, so you're not only fighting the fish, you're fighting the rod. And the torque this twisting causes within the rod shortens its life.

Furthermore, a good angler fights a fish through a sense of feeling that's communicated up the line, through the rod and into his hands. On a traditional rod, the guides are held in place by small feet or tabs that are wrapped to the rod. These feet and the wraps alter the rod's natural flexion, creating small dead spots. Like the spline, these dead spots sap the power from the rod, both in terms of lifting and casting. And when it comes to feeling the fish, your communication is dampened by these dead spots. A guideless rod offers 100% of the rod's continuous, even lifting power spread out over a perfect arc. And since the entire rod is in contact with the line, you get a more sensitive feel for the fish.

There are far more practical considerations as well. There are no guides to come unwrapped or break. No longer will the line wrap around the guides and get tangled, no matter how windy it is. You can even throw ten rods together in a locker or carry a few together in one hand, and they won't become tangled with each other.

The Interlines have other advantages. When you're fishing with a traditional rod and there's no tension on the line, the line sags a little between each of the guides. The actual sag between any two guides is small, but added together over the length of the rod, it can equal a few inches of slack in your line. When that big lunker comes along, that slack and the delay it causes in setting the hook could cost you the fish. Interlines avoid this problem.

The 360° tip also provides a fish-fighting advantage. When a fish gets close to the boat, it often swerves violently from one side of the boat to the other. With a traditional rod you have to twist the rod so the guides are always facing the fish or you could get irregular action from the rod, which will most likely break the line or put slack in it. With its all-around tip and symmetrical construction, the Interline provides equal performance in any direction.

Reality

In actual use, the Interlines felt great. I only experimented with the Long Cast rods briefly on dry land with no breeze, which makes it hard to judge distances, but line seemed to pour off them.

Out on the water that day, our smelly sardines must have been doing their job. We caught four grouper in the 10-pound range and two large snapper as well. The rods performed flawlessly during those battles. They provided quick strikes and lifted the heavy fish out of the rocks, yet they were flexible enough to keep the strain off my back as I reeled the fish up. Moreover, there was a sense of pulling with the entire rod. You could even feel the occasional tail beat. I thought there might be some added friction as a result of the line dragging over the entire length of the rod rather than just through a few guides, but after we caught all those fish, I checked the lines pretty carefully and there didn't seem to be any wear.

If for no other reasons than eliminating broken guides and tangled lines, guideless rods are worth considering. Obviously, they're not a necessity and the whole industry isn't going to switch over in the blink of an eye. Traditional rods still work, especially for those who've spent a lifetime learning how to use them. And no matter how technologically advanced fishing gear becomes, certain indisputable truths remain: A rod is only as good as the angler using it, and most days you're going to drive home with smelly hands. **PM**

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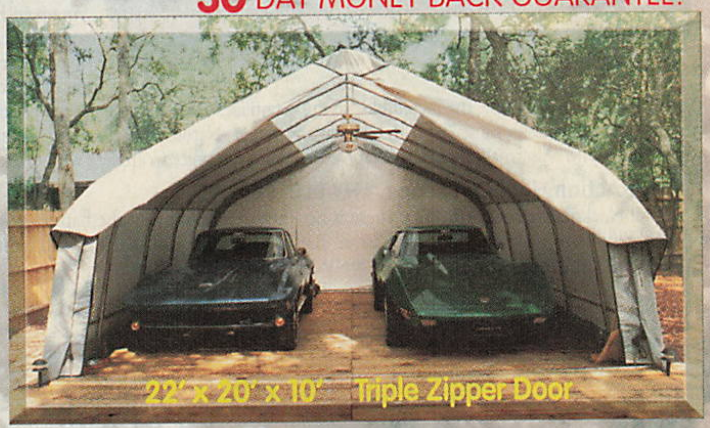

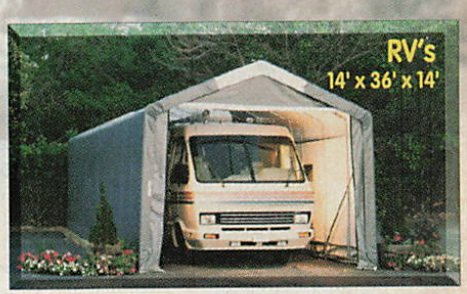

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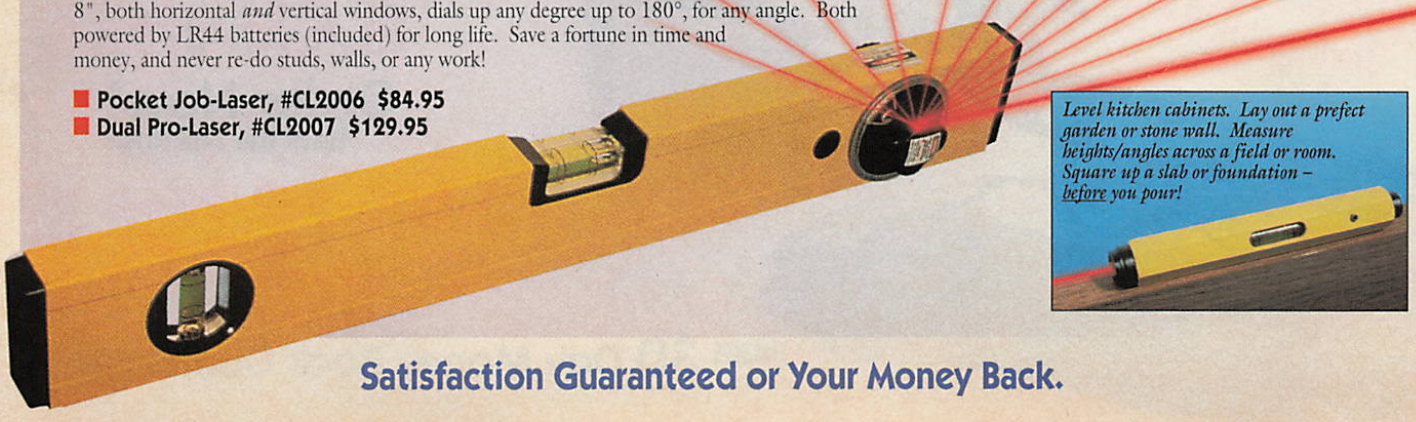

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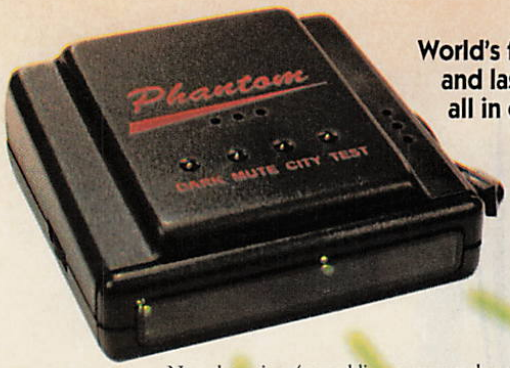

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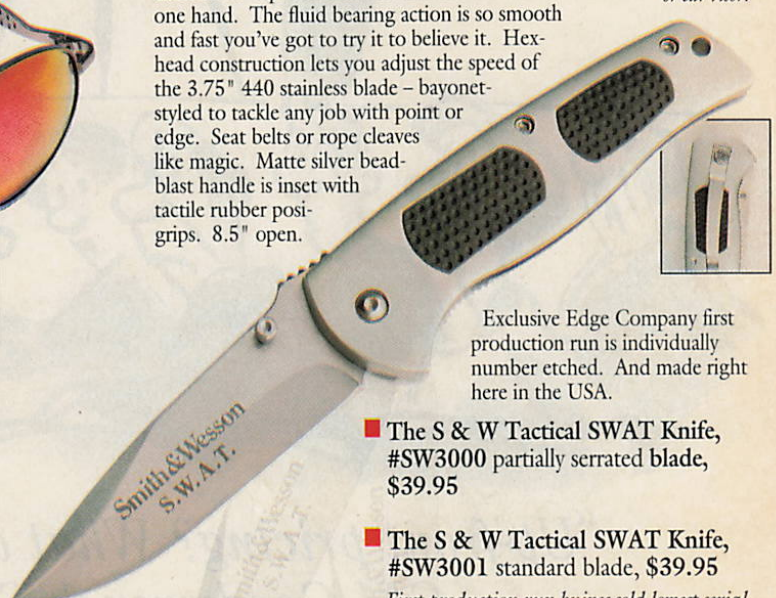

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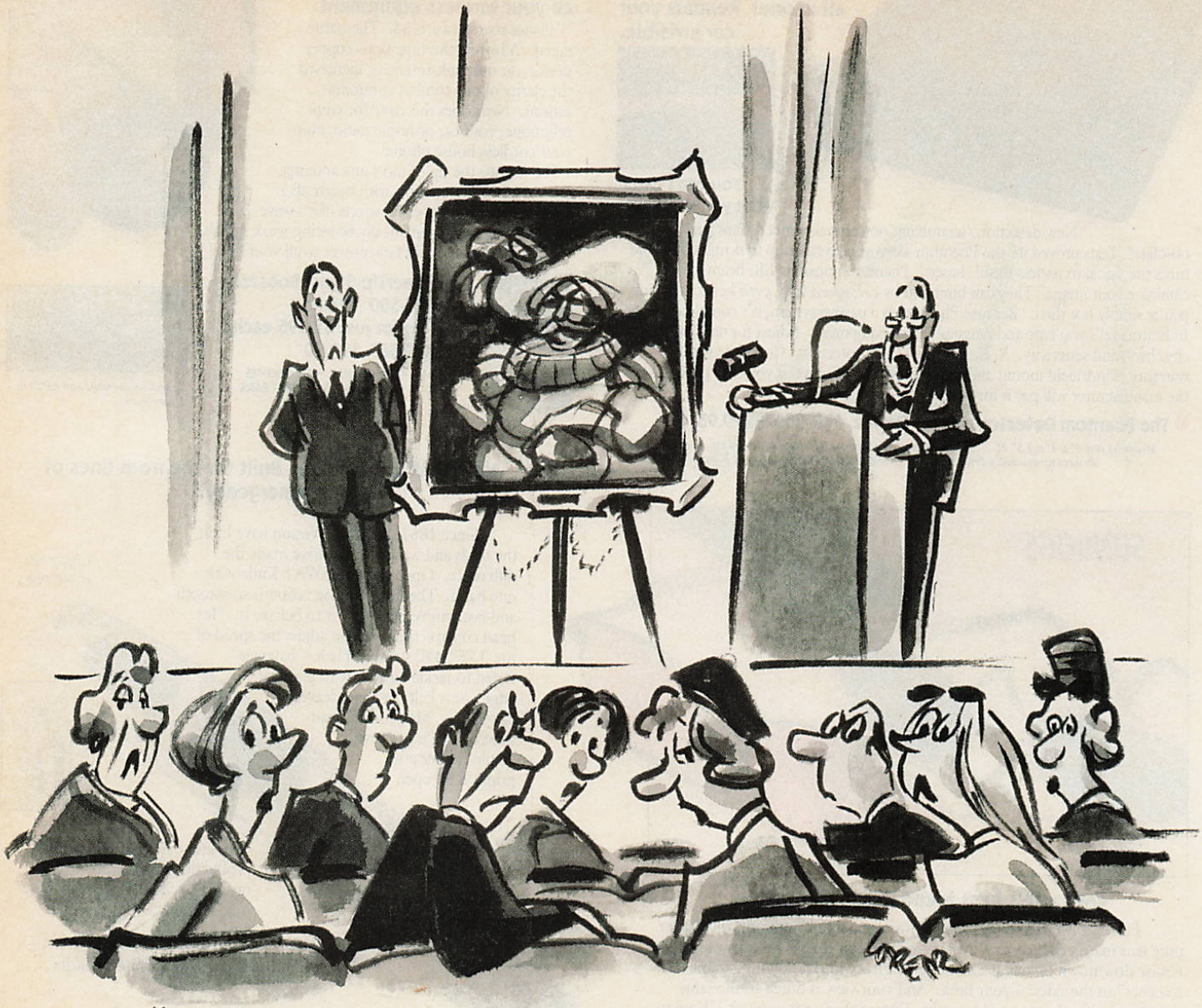

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Popular Mechanics
OCTOBER 1997

HIGH-END HI-FI

Cable at a thousand bucks a foot? A hundred grand for an amplifier?

BY REBECCA DAY; PM Photos by Brian Kosoff

● High-end audio? What makes it high-end? Yes, it costs a bloody fortune. But is that it? Or is there some other intrinsic value to speakers that cost $10,000 a pair? And can you really hear the difference between those 10-grand speakers and a pair that costs $250?

Frankly, we really didn't know the answers to these questions. So we went looking.

What exactly is high-end audio? Ask five audiophiles and you're sure to get five different answers. One will tell you that if you have to ask, you really don't deserve to know. How snobby. Another may tell you it's a clarity of sound and a perceived placement of instruments that cannot be achieved by lower-end equipment.

We also found that there is somewhat of a stigma attached to high-end audio. In the '70s, high-end audio was like an exclusive club. Only golden-eared people were considered worthy of membership, and that snob reputation continues to follow the industry. The rest of us became convinced we had inferior auditory senses. And we asked this question: If we can't hear the difference in audio products, why pay for it?

Truth is, you *can* hear a difference—between recordings, between CD players and between speakers. Whether the cost-benefit ratio is worth it is a subjective choice. It may be staggering to learn that a company sells a $35,000 amplifier, and that people actually buy them. But for the people who design, make and buy the equipment, the investment is worth every musical note.

The power of amplifiers

How do the manufacturing costs of a power amplifier add up to $35,000? The Mark Levinson No. 33 power amplifier is actually two mono amps that operate

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together to produce stereo sound. That accounts for part of the whopping retail price, according to Jon Herron, product development manager for parent company Madrigal Audio Laboratories.

What accounts for a $26,000 difference in power amplifiers? "There's a big difference in size and weight," Herron says, citing the 333's 170-pound frame versus the 33's 375 pounds. In addition, the 33 system can double its power to handle a 1-ohm speaker load—a task that's only a fantasy with most amplifiers. While the $9000 amp delivers a not-so-shabby 300 watts into an 8-ohm load, the $35,000 package pumps 600 watts into a 4-ohm load and a frightening 2400 watts a side into a 1-ohm load. In the No. 33, everything in the signal path between the AC outlet and the speaker must be able to support power and current for 2400 watts into a 1-ohm load. To support that load, the amps use 220- or 240-volt current—the same as most kitchen stoves. All the related cables and IEC receptacles have to be rated to support those levels. Mark Levinson amps boast heavy-gauge power cables, 20-amp outlets, a 5-kv toroidal power transformer, 60 output devices and massive extruded heat sinks.

Still, plugs and cable don't add up to $35,000 or even $9000. So is any 2-channel amplifier worth $9000, let alone $35,000? It's all relative. The amp's job is to put out voltage at any frequency, regardless of the speaker. That's where they get into overbuilding. If you're happy with the sound of a $300 receiver, then what the high-end guys do is overkill.

Amplifier designers make their products sound better by using better-quality parts. They use discrete components such as resistors, capacitors and transistors—or vacuum tubes—rather than assigning those functions to an inherently noisy integrated circuit. Parts like resistors, capacitors and transistors are graded by tolerance level, and those that are built to tighter tolerances cost more.

Another feature often listed on audiophile amp spec sheets is a toroidal transformer. Transformers are required for two reasons: to reduce the line voltage from 120 volts to a number the product can handle, and to isolate the product's circuitry from AC power to ensure safe operation. Standard transformers are square. Toroidal transformers are spherical, which allows them to cancel out electromagnetic fields and produce less hum. You can hand-tune a toroidal transformer by turning it until the hum goes away. Mass-market amp makers can't do this.

Give me a signal

Issues of power are critical in all audio components and particularly so in CD players, which require power supplies for the electrical motors, laser pickup, digital control systems, displays, digital-to-analog converters (DACs) and audio circuitry.

When it comes to a discussion of digital audio, the term "high-end" isn't as easy to comprehend. Digital audio is largely about algorithms and samplings of musical signals. These signals are represented as 1s and 0s, like computer code, and then they are converted to analog wave forms and amplified as music. When you're dealing with logic-based formulas and computer code, it's hard to understand how one digital signal processor (DSP) could produce a better, or more natural, sound than another and why it should cost more.

An ultimate system:
Theta Data III CD transport: $4500
Mark Levinson preamplifier No. 380S: $6500
Theta DSPro Generation VA digital-to-analog converter: $5700
Lexicon DC-1 Dolby Digital surround-sound processor: $4500
Revel Ultima Sub-15 subwoofer: $2500
Revel Ultima LE-1 system: $5000

Buzz Goddard, vice president of Harman International's Lexicon subsidiary, says that the way parts are laid out on a circuit board is largely what determines the actual sound. "Twisting a diode 90° when you place it on a circuit board can affect the product's signal-to-noise ratio, and understanding how only comes from experience," he says. This kind of attention to sonic detail can't be applied to mass-produced products with a shelf life of two years, he says.

The quality of the engine, on the other hand, is fairly irrelevant to the sound, Goddard maintains. "The quality of a DSP engine is like a Pentium chip. It either works or it doesn't. It's the software you write that determines how things sound," he says.

Most DSP circuits use canned programs because they're inexpensive. The result is a very 2-dimensional, processed sound that many people have come to associate with digital signal processing. The DSP modes found on low- to midpriced receivers simulate acoustical environments like stadiums, concert halls and jazz clubs—but not well. Custom DSP software allows manufacturers to manipulate parameters not even available with electromechanical devices—things like room acoustics, correcting for imperfections in transducer technology in loudspeakers and adding psychoacoustic phenomena.

The research into these new areas and the intensive, time-consuming nature of writing software for DSP circuits is what makes Lexicon's DC-1 surround-sound processors sell for $2000 to $4500. The three processors use the same box, but the software inside determines retail price. "It's the same reason I pay $300 for Microsoft Office when the actual CD-ROM only costs $2 to make," Goddard says.

While Lexicon's surround-sound processors are all-digital products, CD players have to convert digital signals to analog output, a process that produces noise. Theta Digital sells CD products ranging from a $700 digital-to-analog converter to an $11,000 2-piece 5A CD player, which includes DAC and CD transport. The sound-quality differences between CD players, according to Theta president Neil Sinclair, are attributable to three areas: computing power, choice of power supplies and circuitry.

Mass-market CD players use digi-

(Please turn to page 115)

Getting connected:
Straightwire Virtuoso balanced interconnect cables 1-meter pair: $450

Straightwire Black Silk speaker cables 8-ft. pair: $1060

MIT OP² Terminator Interface System, 8-ft. pair with 1-meter interconnects: $6000

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BY BILL CONGDON, Associate Publisher

● Leave it to kids to be full of questions. How did they get that crane up to the top of that skyscraper they're building? How did they make that dinosaur eat the man in the movie? How do astronauts live in space? Why is the sky blue? And they expect you to have all the answers.

Being a POPULAR MECHANICS reader, you're probably better prepared to answer these questions than most. But the nonstop curiosity of kids can sometimes overwhelm even the best of us. Stay cool. Help is on the way with the debut of our new television show, "POPULAR MECHANICS For Kids."

The "POPULAR MECHANICS For Kids" TV show, based on our monthly magazine and very popular video series, is a nationally syndicated half-hour show produced by Hearst Entertainment. It debuts the week of Sept. 15 across the country. Most stations will carry the show on Saturday or Sunday mornings. Be sure to check your local television listings for the station and airing time in your area. You can also check our Web site, the PMZone (http://popularmechanics.com) for a complete list of stations.

Each week, the show's teenage hosts, Elisha and Jay, with the help of Charlie, their equally curious neighborhood fix-it shop owner, go where few kids have gone before, taking on new adventures, exploring things most kids can only dream about—flying a jet fighter, creating realistic special effects for a movie, manning the helm of a nuclear-powered submarine, inspecting the world's highest roller coaster and even crawling through a big city's underground sewer system. Elisha and Jay's curiosity provides the spark for each episode. Their search for answers takes them around the country to get hands-on experience and a behind-the-scenes look at things all kids would love to explore and know more about. On "POPULAR MECHANICS For Kids," Elisha and Jay aren't on the sidelines, they're in the middle of everything, and they take you along with them on all their adventures.

Each episode begins with an intriguing event that starts the kids thinking and the questions flying. Outgoing and inquisitive, Elisha and Jay head out on an

adventure to get the answers. Their motto is: "If you want to know more about something, investigate!"

Want to know how a submarine works? The kids find subs you can paddle, subs going to Mars, subs made of wood, and they even get to explore the world's largest operational sub, the Navy's *USS Trident*, which is two football fields long, at its home port of Kings Bay, Georgia.

Have you ever wondered how all those cool special effects are done in movies? Jay and Elisha travel to Universal Studios in Florida to work with the pros in building a movie dinosaur and blowing up a bridge. They even learn the art of making fake blood for those realistic horror movie scenes.

How in the world do those hot new roller coasters stay on track? The kids go to Magic Mountain in Los Angeles for a personal ride, and they even get to operate the roller coaster. They also learn about g-forces, weightlessness and the mechanics of how a roller coaster works.

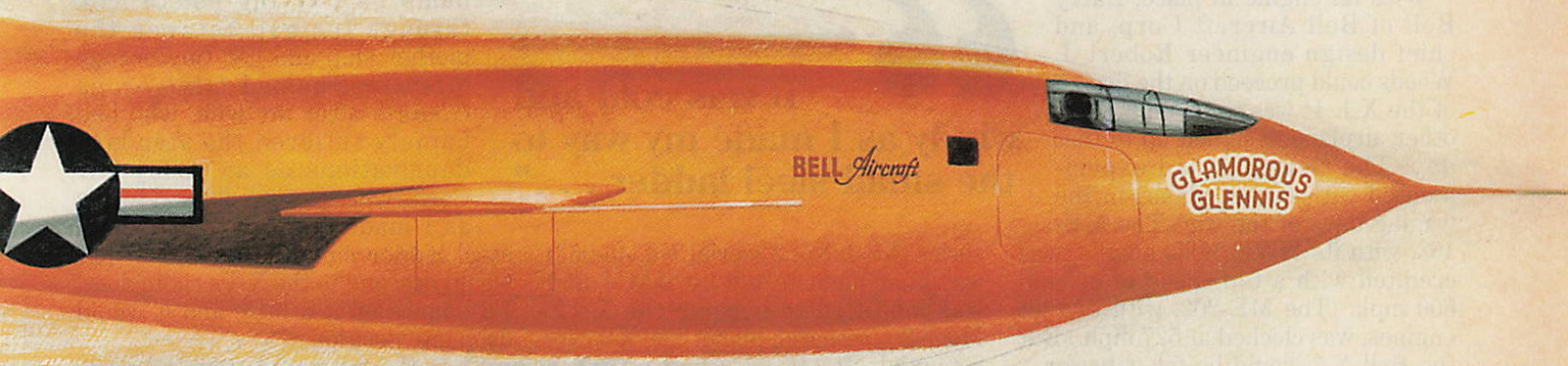
What's it like to live on an aircraft carrier? Elisha and Jay actually ride in a plane that lands on one of these ships. Then they explore this floating city that takes up 4½ acres of ocean and has more than 5000 men and women living on it.

After their weekly field trip, the kids return home and discuss the adventure with their friend Charlie, who gives them everyday tips and performs novel experiments related to many of the things they have just learned in the field. And every week, the show features short segments like the Extreme Pak, where the kids learn about world events related to their adventures. And the Maniac Brainiac Pak features a crazy inventor who shares wacky inventions that may or may not work.

We think "POPULAR MECHANICS For Kids" is a great show for the whole family. It's television that combines the fun and the excitement of adventure with learning, all from a kid's point of view. It's a show that will not only help you answer all of those questions that you dodged because you didn't have enough information, but will probably encourage the kids in your life to ask even more. And that's a good thing. **PM**

6062
AD INEXPLORATA

BREAKING THE SOUND BARRIER



Fifty years ago, a test pilot with the right stuff changed the future of aviation forever.

BY GEN. CHUCK YEAGER (USAF, Retired)

Editor's Note: This article originally ran in our November 1987 issue. It was the 40th anniversary of the day Gen. Yeager climbed into the Bell X-1 and became the first man to travel faster than the speed of sound. This month, in commemoration of the 50th anniversary of the event, we reprint his account of that day.

● The joke was on me.

It was just after sunup on the morning of Oct. 14, 1947, and as I walked into the hangar at Muroc Army Air Base in the California high desert, the XS-1 team presented me with a big raw carrot, a pair of glasses and a length of rope. The gifts were a whimsical allusion to a disagreement I'd had the previous evening with a horse. The horse won. I broke two ribs. And now, as iridescent fingers of sunlight gripped the eastern mountain rims, we made ready to take a stab at cracking the sound barrier—up until that point aviation's biggest hurdle.

The Bell XS-1 No. 1 streaked past the speed of sound that morning without too much fanfare—broken ribs notwithstanding. And when the Mach indicator stuttered off the scale barely 5 minutes after the drop from our mother B-29, America entered the second great age of aviation development. We'd fly higher and faster in the XS-1 No. 1 in later months and years. Its sister ships would acquit themselves ably as the newly formed U.S. Air Force continued to "investigate the effects of higher Mach numbers." And Edwards Air Force Base, formerly known as Muroc Army Air Base, would witness remarkable strides in supersonic and even transatmospheric flight.

But with the XS-1, later shortened to X-1, we were flying through uncharted territory, the "ugh-known" as we liked to call it. And as ominous as it seemed to us then, that was the whole point. America was at war with Germany and Japan in December 1943 when a conference was called at the fledgling National Advisory Committee for Aeronautics (NACA, NASA's forerunner) in Washington. The subject was how to provide aerospace companies with better information on high-speed flight in order to improve aircraft design. A full-scale, high-speed aircraft was proposed that would help investigate compressibility and control problems, powerplant issues and the effects of higher Mach and Reynolds numbers. It was thought that a full-scale airplane with a trained pilot at the controls would yield more accurate data than could be obtained in a wind tunnel. And, following the English experience with early air-breathing jet propulsion, the notion of using a conventional jet powerplant was advanced.

Discussions continued through 1944, but winning the war was first on everyone's agenda. It wasn't until March of 1945, with the war drawing to a close, that the project picked up momentum. Researchers concluded, however, that jet engines of the period weren't powerful enough to achieve the required speeds. Rocket propulsion was explored—specifically, a turbopump-equipped rocket made by Reaction Motors Inc.

X-1 streaks into a new age (above). Other X-1 views (top left) the rocket plane's B-29 mother ship and (lower left) cockpit design. Yeager's X-1 awards and insignia include, from left: Federation Aeronautique Internationale gold medal, Presidential Medal of Freedom and Air Force research patch "Toward the Unknown."

PM ILLUSTRATION BY HOWARD KOSLOW

Delivering 6000 pounds of thrust, the acid-aniline-fueled engine was believed to be capable of boosting an airplane to the fringes of the known performance envelope. Ultimately, the Reaction Motors turbo pump became stalled in development, so another 4-chamber Reaction Motors engine, this one fueled by liquid oxygen and diluted ethyl alcohol, was slated for installation. A pressure system using nitrogen gas provided a basis for fuel delivery. This fallback meant the X-1 could carry only half the fuel originally anticipated, but at least the project could move ahead.

With an engine in place, Larry Bell of Bell Aircraft Corp. and chief design engineer Robert J. Woods could proceed on the design of the X-1. It was to be unlike any other airplane designed up to that day. The Germans had experimented with rocket planes in the waning days of the war. The ME-163, with its HWK 509C engine, was credited with a top speed of around 600 mph. (The ME-262, with two jet engines, was clocked at 527 mph.) But the Bell X-1 would be far superior—with a clean, aerodynamic profile that whispered "power" even while dormant on the tarmac. The nose was shaped like a .50-cal. bullet, and its high-strength-aluminum fuselage stood a mere 10.85 ft. high and 30.9 ft. long. Wingspan was 28 ft. and wing area was 130 sq. ft. Launch weight was 12,250 pounds. Landing configuration was close to 7000 pounds. Packed inside the X-1's diminutive frame were two steel propellant tanks, 12 nitrogen spheres for fuel and cabin pressurization, three pressure regulators, retractable landing gear, the wing carry-through structure, the Reaction Motors engine, more than 500 pounds of special flight test instrumentation, and a pressurized pilot's cockpit. Performance penalties, fuel limits and safety concerns dictated an air launch by a specially modified B-29. (However, I did make a successful ground takeoff on Jan. 5, 1949.)

The Army Air Technical Service awarded the contract for the XS-1 No. 1 (serial No. 46-062) to Bell on March 16, 1945, the first of six in the X-1 series. XS-1 No. 2 (serial No. 46-063) was later flight-tested by NACA and was modified to become the X-1E Mach 2+ research plane. The X-1 No. 3 (serial No. 46-064) had a turbopump-driven, low-pressure fuel-feed system. It was destroyed in an explosion on the ground in 1951. The X-1A, X-1B and X-1D were also test-flown. The A and D were also lost to propulsion system explosions.

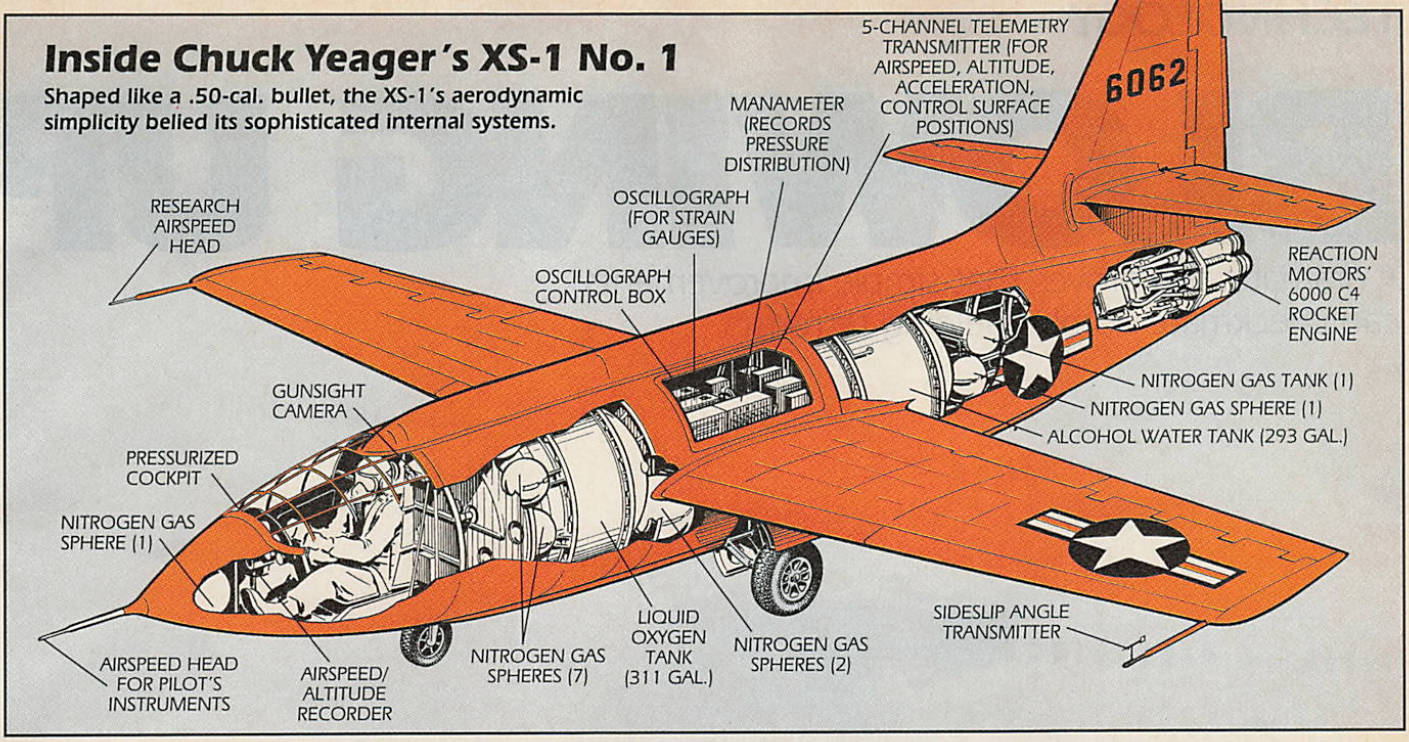
"It was cold and windy as I made my way to the small steel ladder . . ."

You get the idea that designing, maintaining—and particularly flying—these research tools was not without hazard. But despite the risks, the first X-1 flew like a dream. Its smooth, precise flight characteristics defined the plane's personality. I remember pulling three slow rolls on the first unpowered flight in midsummer 1947. And as we embarked on the quest to explore aviation's potential, fear—albeit subsurface—supplied a businesslike edge to the work. It lurked in the shadows of the psyche as the great B-29, piloted by Maj. Bob Cardenas, lumbered into the crystalline California air with the X-1 clutched to its underbelly. The bomber's gear would come up and the prospect loomed of having to get into the driver's seat of the X-1 "in the usual fashion," as the unemotional post-flight reports described it. It was the worst part of the whole ride—suited more for a contortionist than a pilot.

At altitude, engineer Jack Ridley and I would stroll back to the bomb bay, trying not to look through the gap between the mother ship and her tiny orange offspring, named *Glamorous Glennis* after my wife, who had happily suffered the standard deprivations as an Army Air Corps wife. It was cold and windy as I made my way to the small steel ladder mounted on slides that would descend to the X-1's cabin door. I'd bounce on it a little and it would drop into position.

Then the fun would start. I'd place my right hand up inside the door and hold on tight to the top of the frame—inches away from all that sky. Then I'd slide in feetfirst with my left hand still holding the ladder behind my back. I'll never forget that bad moment when I'd have to release my right hand and shift my weight from the ladder to the plane. This was the moment—half in and half out—when I always figured the X-1 would get inadvertently released (crack!) from the cable attachment point overhead. Once inside the plane, I'd have to bend around double to turn and slide into the pilot's seat. But it wasn't over. I'd still have to contend with the parachute (as much good as it would do in an emergency) and retrieve my helmet and oxygen mask from behind the seat—I'd stuffed my helmet and oxygen mask behind the seat of the X-1 before takeoff, two less items to worry about.

Yeager between flights in the X-1.


Inside Chuck Yeager's XS-1 No. 1
Shaped like a .50-cal. bullet, the XS-1's aerodynamic simplicity belied its sophisticated internal systems.
5-CHANNEL TELEMETRY TRANSMITTER (FOR AIRSPEED, ALTITUDE, ACCELERATION, CONTROL SURFACE POSITIONS)
6062
MANAMETER (RECORDS PRESSURE DISTRIBUTION)
OSCILLOGRAPH (FOR STRAIN GAUGES)
RESEARCH AIRSPEED HEAD
OSCILLOGRAPH CONTROL BOX
REACTION MOTORS' 6000 C4 ROCKET ENGINE
NITROGEN GAS TANK (1)
NITROGEN GAS SPHERE (1)
ALCOHOL WATER TANK (293 GAL.)
GUNSIGHT CAMERA
PRESSURIZED COCKPIT
NITROGEN GAS SPHERE (1)
SIDESLIP ANGLE TRANSMITTER
LIQUID OXYGEN TANK (311 GAL.)
NITROGEN GAS SPHERES (2)
NITROGEN GAS SPHERES (7)
AIRSPEED HEAD FOR PILOT'S INSTRUMENTS
AIRSPEED/ ALTITUDE RECORDER

When I'd settled, Ridley would lower the cabin door on a small cable and position it over the doorframe. He'd push from the outside and I'd latch from the inside and somehow, in the icy wind, with thinning oxygen and mounting anticipation, we'd get the X-1 ready for flight.

The drop itself was the next big obstacle, and like entering the bird, it's something that I never really got used to. During preflight checks, I'd practice neutralizing the controls and brace myself for the release. Cardenas would go through the countdown, finishing with an emphatic "Drop!" The X-1 would float from the B-29 and I'd get launched right up to the cockpit overhead, caressing the canopy with my helmet in the sudden swell of microgravity. My heart was in my mouth, stomach right behind it.

"If I could get into the pilot's seat, I knew I could fly."

The pilot's reports I wrote afterward were devoid of these sensations—as a professional test pilot, you were expected to maintain a dispassionate tone. Consider these excerpts from the report following the eighth powered flight: "After pilot entry in the usual fashion at 7000 ft., the XS-1 was dropped from the B-29 at 20,000 ft. and at 260 mph indicated airspeed. . . . Immediately after the drop, all cylinders were started in rapid sequence, and with all four in operation it was noted that No. 1 and No. 3 had 210-psi chamber pressure, No. 2 and No. 4 having 220 psi, with approximately 290-psi LOX and fuel line pressure. . . . The climb was made at .85 to .88 Mach until 40,000 ft. was reached. . . ."

That flight, on Oct. 10, signaled enormous progress in the X-1 program. We thought it was only a matter of time before we'd push through the sound barrier. What would it be like? A pebble in the road of aviation we had merely to step over? Or an insurmountable Chinese Wall that would destroy the X-1—and me with it? Naturally, thoughts at these moments turned to Glennis and my boys, who sacrificed plenty out in the desert in those brightly lit days of the late 1940s. I wanted to fly, wanted to take my shot at the speed of sound. And they were my own personal cheering section.

As I stood looking at my carrot, my glasses and my rope on the morning of Oct. 14—broken ribs secretly knifing at my side—I thought that this just might be the day. The eighth powered flight had gone exceedingly well. We had flown as fast or faster than anyone ever had before. And it looked as though we only had to step over the line to enter aviation's new age. The day of the ninth powered flight began in the usual way. I fried the eggs while Glennis got ready to drive me over to the airfield. I'd had a bad night's sleep—from the pain in my side, but also from the indecision about whether or not to fly the mission incapacitated. Tossing and turning, I decided to make up my mind in the air. If it became physically impossible to climb into the X-1, then I'd scrub the mission. If I could get into the pilot's seat, I knew I could fly.

As the team swarmed over the X-1, with cords from trouble lights dangling in the early morning gloom, and tools, racks, ladders and other gear surrounding the little ship, Ridley began the preflight coaching. "We got that Drene shampoo for the windshield," he said, "so you shouldn't have any trouble with the windscreen frosting over. Now remember, you play around with the stabilizer setting before you make your high-speed run. We know you'll lose some elevator control, so find out where you get the most longitudinal control with the stabilizer. Try it at different settings and different speeds above .85 or .86 Mach." Discussions continued over coffee. There was a heightened intensity, a new determination, on the part of everyone involved. This was it. This was the day. Would it end with another record shattered? Or with failure's grim finality?

After the X-1 was fueled, I returned to the ready room with Ridley to don my flight suit. Briefings continued, peppered by admonitions and warnings: "Under no circumstances are you to . . .," "In the event of . . .," "You'd better be sure to . . . ." Their whole point was to make sure I didn't take the X-1 over .96 Mach if I didn't think the plane could handle it.

Fear crouched in the deep recesses of the mind—present, accounted for, but well controlled. With the fueling and mating procedures completed, I walked back out to the B-29 and stooped low to make a last-minute check of the X-1's instrumentation. My helmet and oxygen mask were well secured behind the seat, I jogged

(Please turn to page 116)

PM ILLUSTRATION BY FRED WOLFF
AIR PHOTOGRAPHIC AND CHARTING SERVICE/U.S. AIR FORCE PHOTO

BLOWING UP

A dramatic test proves that simple improvements can checkmate bomb-wielding terrorists.

BY JIM WILSON, Science/Technology Editor

● In less than a minute, bombs will shower England's Bruntingthorpe Airfield with the jagged remains of a Boeing 747 jumbo jet.

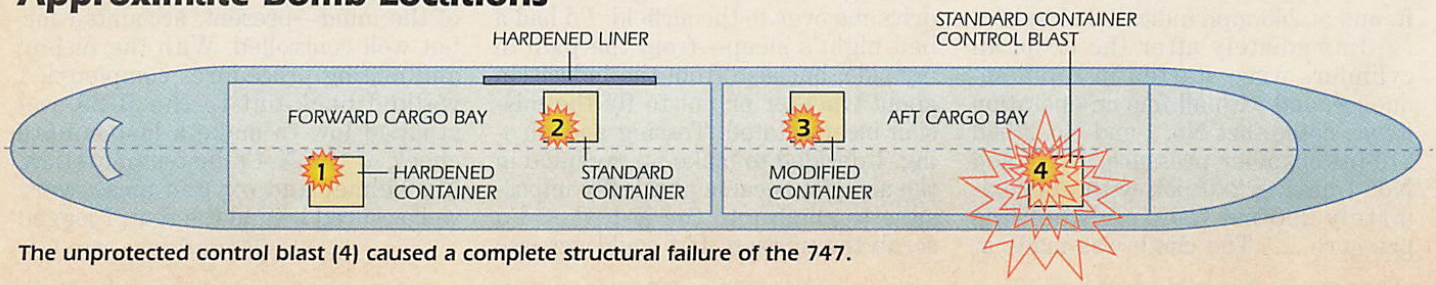
"We cannot tell you their exact size and location," says Richard Wright, a spokesman for the Civil Aviation Authority (CAA), which is sponsoring one of the most dramatic experiments in aviation history. They are about to blow up a retired Air France 747. If the experiment plays out as expected, the CAA will have solid proof that simple improvements in baggage container and cargo bay design can minimize the damage of terrorist bombs, like the one that downed Pan Am Flight 103 over Lockerbie, Scotland, in December 1988.

Wright's colleague, Rory Martin, suggests I pay especially close attention to the rear of the doomed plane. "We concentrated on the cargo bay," he explains. "We want to know how the explosions work, how structures fail." To this end, one of the four bombs has been placed inside a standard baggage container, close to an unprotected section of fuselage.

Taking Martin's advice, I aim my binoculars at a spot between the tail and the wing as I listen to the final countdown. *Three, two, one* . . . Four explosions detonate simultaneously. Inside the aft cargo bay, the pressure wave from one of the blasts has blown through a standard baggage container as if it were just wrapping paper. Unimpeded, these rapidly expanding, high-temperature gases hammer into the fuselage.

To make the experiment more realistic, the interior of the plane was pressurized. Creating just the right amount of pressure proved to be one of the day's most difficult challenges, and it caused several holds in the countdown. During one of these delays, Chris Peel, a top British structures and materials expert, told me

Approximate Bomb Locations



The unprotected control blast (4) caused a complete structural failure of the 747.

A 747

AP/WIDE WORLD PHOTOS BY DAVID JONES (TOP); MARTIN CLEAVER (INSET)

Had this explosion occurred in flight, the entire plane would have been lost. As little as 14 ounces of explosive can trigger disaster.

why getting the pressurization right was so important to the outcome of the experiment. "If the aircraft is unpressurized, small cracks will produce minor damage. Catastrophic damage occurs when the pressure difference amplifies the damage, causing the cracks to run," he says.

These amplifying effects soon become apparent. The explosion creates a jagged tear that races forward to the wing, makes a 90° turn and then splits the skin along a line of rivets around the fuselage. The tail section slumps down on the runway. A cloud of fire-extinguishing carbon dioxide gas is released to smother any secondary fires that may have erupted.

After this gas has dispersed, I am allowed a closeup look at the damage. "The standard container was virtually transparent to the explosion," says Peel. A container hardened with a material similar to that used in bulletproof vests and placed near the front of the forward cargo bay (see diagram on opposite page) appears to have fully contained the force of the bomb planted inside.

A second standard 5 × 5 × 5-ft. container also has been demolished, but there is little visible evidence of this outside of the plane. A 15-ft. "bulletproof" panel placed against the fuselage as a sort of shock absorber apparently has performed as advertised. There is likewise no evidence of damage to the fuselage next to a standard baggage container that has been modified by the addition of an 8-in. foam liner.

It will be late fall before the Defence Evaluation and Research Agency, which conducted the experiment for the CAA, issues its final report. But a cursory inspection shows that technology for blunting terror's threat is at hand. "If you put all the changes together," suggests Martin, "they make a good system." **PM**

STERN T

Mercruiser's new 240-hp D-Tronic sterndrive diesel faces off against the company's 250-hp gas-powered standard.

BY JIM GORANT, Outdoors Editor; PM Photos by Skip Gandy

• Don't confuse durable and reliable. For instance, use durable paint, but don't tell people you have a reliable paint job. Your mailman should be reliable, but you could probably care less if he's durable, provided his replacement is equally reliable. And while it's no problem to say your wife or girlfriend is a reliable person, it could get ugly if you call her durable.

There are, however, things that should be both durable and reliable: Condoms and pacemakers come to mind. Marine engines also fall into this category. With the number of leisure activities increasing and leisure time on the decline, using your boat should be a turn-the-key-and-go proposition. No pumping the throttle for 15 minutes and revving her in idle while a trail of white smoke blots out what was once a beautiful day. Just reliable starts and durable performance. Otherwise, why would anyone bother?

Such carlike operation was foreign to the boating world until a few years ago when electronic fuel injection (EFI) came to marinized engines. Now, for the most part, boaters can get the kind of instant startup they've become accustomed to in their driveways. At the same time, diesel engines, which have long provided large boats with the most durable form of power available, have become better suited for use on smaller boats. Instead of a heavy, low-revving engine with lots of low-end torque, the new diesel is smaller, lighter and higher-revving—better at providing the kind of explosive propulsion needed for running most runabouts and cruisers.

O STERN

In the last few years, MerCruiser has sought to combine reliability and durability in all its engines. For instance, the company has just introduced the Horizon, a marinized version of the Northstar engine. The 380-hp 454 requires oil and filter changes once a year for the first three years, and that's it. Throughout its line, the company has upgraded component parts and redesigned systems to reduce maintenance. So it follows that MerCruiser would try to marry the reliability of EFI to the durability of a diesel.

The injection system is known as D-Tronic, and it goes with three new turbocharged, intercooled diesel engines: the D7.3L rated at 300 hp at the crankshaft, the D4.2L at 240 hp, and the D2.8L at 165 hp. The smaller two engines are available as inboards, and for sterndrive applications the horsepower drops to 225 and 150, respectively. All three can be matched with the company's Bravo One, Two or Three drive units.

The showpiece of the line is the V-8 D7.3L, with its innovative, hydraulically activated, direct-injection system. At the heart of the engine, a microprocessor-based Electronic Control Unit (ECU) oversees seven sensors that monitor throttle and camshaft position, injection control position, turbo pressure, oil temperature and pressure, coolant temperature, and outside air temperature and pressure. Using this information, the microprocessor computes the precise amount of fuel to be injected, the injection pressure and the injection timing, ensuring optimal fuel burn. As a result, the engines should produce minimal smoke and emissions while offering economy and performance.

The ECU controls a rail-pressure control valve on the oil pump that varies outlet pressure between 450 and 3000 psi. This highly pressurized oil is delivered to each of the engine's eight injectors, where it activates the plungers hydraulically. Inside each injector, an intensifier piston translates the hydraulic rail pressure into injection pressure and multiplies it seven times. This means that 21,000 psi are available at the injection point, which translates into a more complete burn

and more power. Also, both the start and end of the injection sequence are electronically controlled, so timing can be advanced or retarded without mechanical limits.

Not quite as sophisticated as their big brother, the inline 6-cylinder D4.2L and inline 4-cylinder D2.8L still offer electronically controlled fuel delivery. An ECU in the fuel pump monitors throttle position, turbo pressure and temperature, engine speed, injection timing, fuel temperature and injection pump position. Fifty times every second, the ECU processes this information and determines how much fuel to inject and when.

We wanted to see just how these new diesels stacked up with their gas counterparts. MerCruiser and Sea Ray helped out by building two identical 25-ft. Sundancers, one with MerCruiser's carbureted 250-hp 5.7LX gasoline engine and the other with the 240-hp D4.2L D-Tronic. Both were connected to Bravo Two sterndrives.

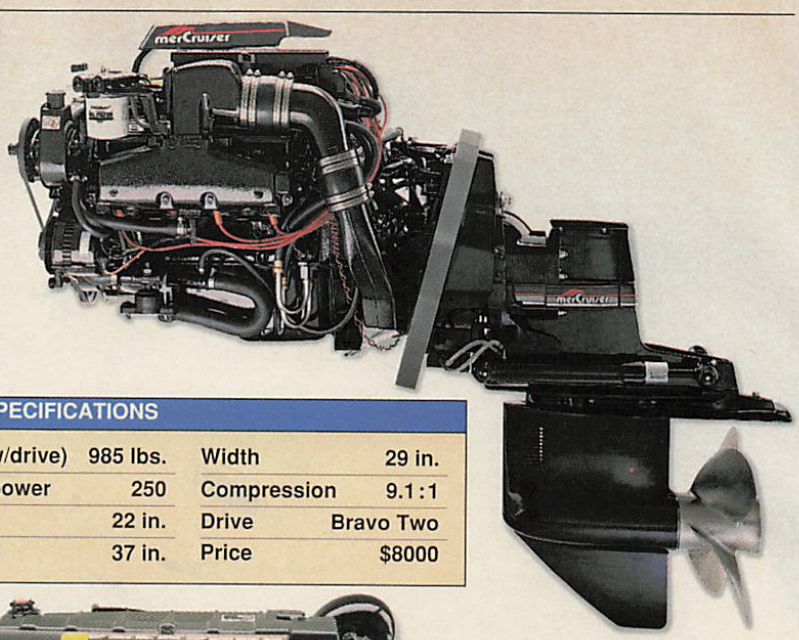
Since diesels are generally regarded as slower, louder and smellier, the surprises started as soon as we turned the key. There was no smoke and I didn't smell any offensive fumes the entire time we ran the boat. (Note: We didn't spend much time at idle or near the stern of the boat.) The second surprise came when we compared the sound readings. The diesel was louder at lower speeds, but as rpm increased, the decibel readings leveled out until they were almost identical. Moreover, the gas engine produced the high-pitched whine that rings in your ears, while the diesel put out a less abrasive rumble that reverberated in your sternum.

But the biggest surprise came in the speed category. At wide-open throttle, the two boats were virtually identical, with the diesel actually coming in .5 mph faster. Since the engines don't produce the same rpm, it's impossible to continue the comparison right down the line, but you can compare each engine's most efficient cruising speed. On the gas boat, it's 3500 rpm, which produced 28 mph while burning 11.8 gph and providing a 149-mile range. Meanwhile, the diesel boat's 3000-rpm cruise pushed it to 26 mph with a 6.3 gph fuel burn and a 261-mile range. That's nearly double the fuel efficiency at a similar speed, and the ratio is even better at other points along the spectrum. The gas boat did, however, seem to have more punch, a feeling borne out by its 0-30-mph acceleration which was 1.5 seconds faster.

But numbers don't tell the whole story. Out on the water, the 250 Sundancer and the D4.2L made a satisfying boat-engine package. Most diesels accelerate slowly until the turbos kick in, but when I leaned on the throttle, the power was immediate and impressive. Once on plane, the diesel boat was more sensitive to the trim tabs, and seemed to need more adjustment to run at a comfortable attitude, probably because the D-Tronic weighs 272 pounds more than the gas engine.

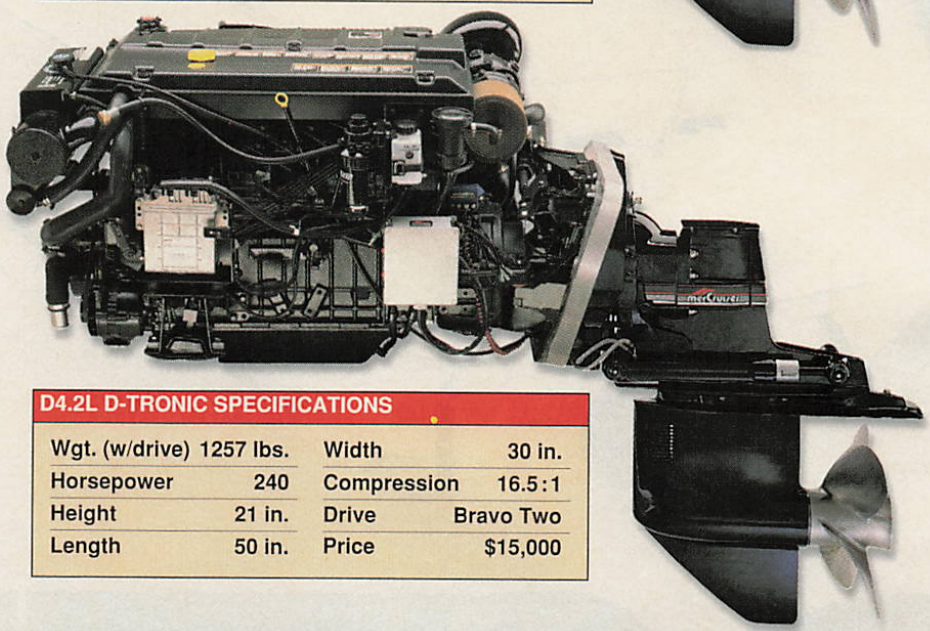
The added weight may also cause the slight difference in handling between the two boats. While both performed well during hard-over turns, the gas boat seemed more agile and responsive during faster, shorter turns. The diesel boat handled well, but didn't return to its center of balance as quickly after a turn, although to such a slight degree that you probably wouldn't notice if you weren't doing side-by-side tests.

They differed, however, in price. Sold as a package with a boat, the D4.2L costs $15,000, versus around $8000 for a 5.7LX package (add 10 to 15% to buy just the engine). While the diesel may save you money in terms of service, maintenance and fuel, you'd have to own the boat for a long time for it to equal out. Of course, it's hard to put a price on increased reliability and durability. **PM**



5.7LX SPECIFICATIONS

Wgt. (w/drive)	985 lbs.	Width	29 in.
Horsepower	250	Compression	9.1:1
Height	22 in.	Drive	Bravo Two
Length	37 in.	Price	$8000



D4.2L D-TRONIC SPECIFICATIONS

Wgt. (w/drive)	1257 lbs.	Width	30 in.
Horsepower	240	Compression	16.5:1
Height	21 in.	Drive	Bravo Two
Length	50 in.	Price	$15,000

TEST RESULTS

RPM	MPH		GPH		MPG		RANGE		DECIBELS	
	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel
1500	6.0	7.0	2.6	1.2	2.31	6.09	145	383	71	78
2000	8.0	8.0	4.6	2.9	1.74	2.76	109	173	76	82
2500	12.5	17.5	6.9	4.5	1.81	3.89	114	245	80	83
3000	19.5	26.0	8.7	6.3	2.24	4.15	141	261	83	84
3500	28.0	32.0	11.8	8.3	2.37	3.86	149	242	88	88
4000*	31.5	36.0*	16.1	10.5*	1.96	3.43*	123	216*	89	90*
4500	35.5		21.2		1.67		105		91	

*** 3800 was the top rpm on the D4.2L D-Tronic.** Temperature: 82. Humidity: 80%. Wind: light. Water condition: calm. Speed: 2-way average measured with radar gun. Fuel: Measured with FloScan meter and Techmate diagnostic tool. Range based on 90% of advertised capacity. Sound: Measured on A scale.

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DANA

48 HOURS IN MISSION CONTROL

BY JIM WILSON, Science/Technology Editor

● Ever since a Delta II rocket lifted NASA's *Pathfinder* mission off Cape Canaveral pad 18B during a dazzling middle-of-the-night launch last Dec. 4, POPULAR MECHANICS had been tracking its flight to Mars. With the spacecraft closing in fast on the Red Planet, we checked in with mission control to watch the last critical hours of the flight.

When I arrived at the Jet Propulsion Laboratory in Pasadena, California, *Pathfinder* was as far from Mars as the Moon is from Earth. Dispatches from the NASA newsroom had announced that the mission was on schedule for its Independence Day rendezvous. What the dispatches didn't convey was the growing tension inside mission control, where a new generation of explorers was opening a new chapter in space exploration. In the next 48 hours, they will make crucial decisions, endure the longest minutes of their lives and watch a tiny robot frolic 191 million miles from home.

"There are lots of ways of going to the planets," Rob Manning, JPL flight systems chief engineer, tells me. "All of them are hard."

And risky. Of the 22 Mars missions undertaken by the United States, the former Soviet Union and Russia, nine were outright failures. Since *Viking 2* touched down on Mars on Sept. 3, 1974, every mission to the Red Planet—except America's *Global Surveyor*, which was en route—had failed. The Soviets' *Phobos 1* and *2* spacecraft disappeared. The American *Mars Observer* stopped transmitting just before it was scheduled to arrive in orbit around Mars on Aug. 22,

AP/WIDE WORLD PHOTOS/KEVORK DJANSEZIAN PHOTO

Behind the scenes at NASA's Jet Propulsion Laboratory as *Pathfinder* makes its historic touchdown on Mars.

Mission control unveils the first 3D photo of Mars next to an artist's rendering that also shows *Sojourner*.

1993. The latest in this string of disasters occurred only weeks before *Pathfinder* successfully launched. On Nov. 11, 1996, the rocket lifting Russia's *Mars96* mission exploded. In light of these mishaps, the tension in mission control is understandable.

Rumor has it that, to help ward off a last-minute disaster, the JPL crew has taken one final precaution that isn't in the flight manual. It's said that they've laid in a stock of peanuts, just like during the heyday of Mariner flybys and Viking landings on Mars. Peanuts were absent the night *Observer* died.

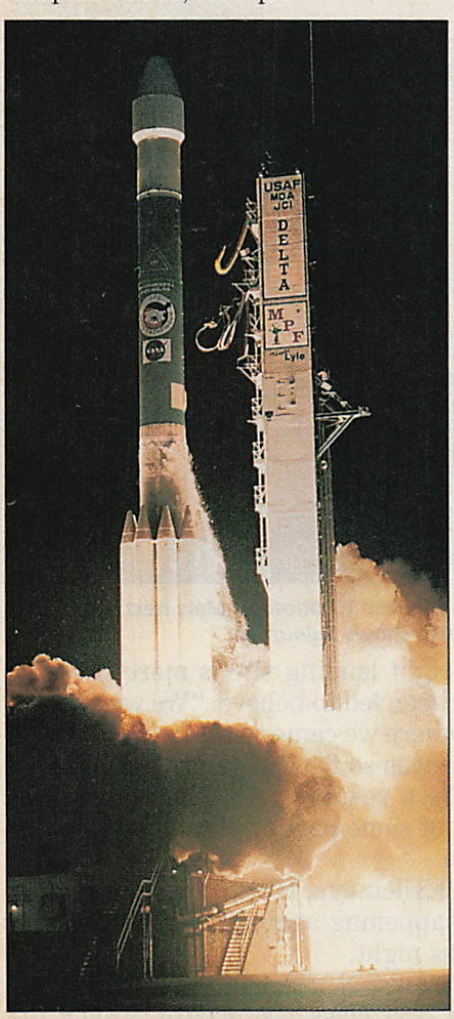
About the same time that I'm presenting my press credentials, the team in mission control is grappling with its first critical decision: making sure *Pathfinder* lands in the Ares Vallis, located approximately at the planet's waist (see photograph on page 64). The pressure to get to the right landing site is more pressing than the public has been led to believe. "We were never able to determine where we came to rest with *Viking 2* because the surface was so flat," says project scientist Matt Golombek. As a result, NASA has thousands of excellent photos of some part of Mars, but its exact location is unknown.

It's up to Pietier Kallemeyn, *Pathfinder's* navigator, to keep this from happening again. The responsibility has led to a sleepless night.

In the Viking missions, NASA had the means to set its envoys down in first class. An orbiter circled the planet and then released a landing vehicle. But as a result of cost runovers on the space shuttle and inter-

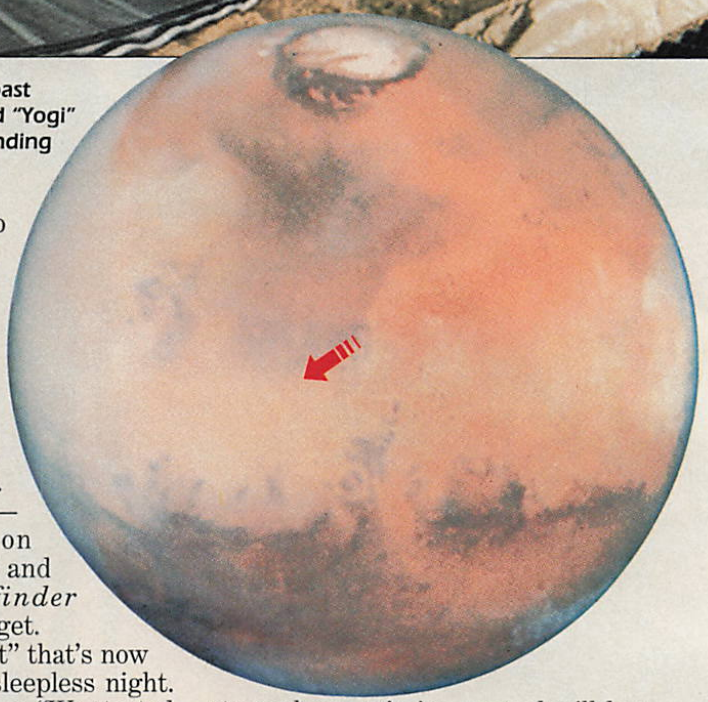
national space station, the *Pathfinder* mission—indeed, all planetary exploration after the *Cassini* Saturn mission that launches in October—must travel coach.

One way to save money is to get rid of the orbiter and just fly straight into Mars. So instead of working its way onto the green before aiming at the flag, NASA is shooting for a hole in one, albeit with a radio-controlled golf ball. This means that *Pathfinder* will approach Mars 80% faster than *Viking 2* did. The space agency says *Pathfinder* will hit the Martian atmosphere at 16,660 mph.



Pathfinder **began its mission aboard a Delta II rocket. The trip ended with it bouncing on Mars at about 50 mph.**

Sojourner **makes its way past "Barnacle Bill" and toward "Yogi" (top). The approximate landing area in Ares Vallis (right).**



Because there is no orbiting, during which last-minute corrections could be made, the straight approach requires fine-tuning of *Pathfinder*'s flight path with four or five trajectory correction maneuvers (TCMs). The first four TCMs—executed flawlessly on Jan. 9, Feb. 3, May 6 and June 25—put *Pathfinder* almost perfectly on target.

And it is this "almost" that's now causing Kallemeyn a sleepless night. "I'm pretty tired," he says. "We started this 12 hours ago." Kallemeyn must be awake and alert for both "windows," periods during which mission control could order *Pathfinder* to fire rockets to make final corrections. The first window occurred 12 hours before the spacecraft was scheduled to enter the Martian atmosphere (the second will arrive 6 hours later). As the countdown for the close of the first approaches, the team rechecks their calculations using data broadcast back over NASA's Deep Space Network. They believe they are on target, but if they're wrong, there is still one more opportunity to make a correction.

Around 4 am, the last window appears. The navigation team again decides the best decision is a no-fire decision. ("When we decided not to do TCM 5, it was a great relief," Kallemeyn would say later.) So, if the calculations are right, *Pathfinder* will land somewhere within a 120 × 60-mile ellipse. Exactly where it will come to rest depends on the density of the atmosphere and how well the craft bounces. And how well it bounces depends on how well Tom Rivellina has done his job.

During its entry into the Martian atmosphere, mission control will lose contact with *Pathfinder*. There couldn't be a worse time to be out of touch. About 70 seconds after entering the atmosphere, it will experience 20 g's of pressure. Near the end of this ride, at an altitude of about 4 to 6 miles from the surface, the parachute will shoot out of its canister. Once deployed, it will slow *Pathfinder*, and in so doing, change the ship's trajectory—about a 14° angle—to a nearly vertical fall.

But even if the spacecraft's heatshield, deacceleration rockets and parachute all function as planned, the mission could still be reduced to about 1500 pounds of bent metal and fractured electronics. *Pathfinder* still needs to be able to bounce, and for this to occur, a cocoon of airbags must inflate at about 1000 ft. above the Martian surface. It is Rivellina's job to make sure this happens.

"I didn't sleep. I was psyched, absolutely psyched," Rivellina would say afterward, tugging at a piece of the tent-cloth-like material used to make the man-size soccer balls that cushioned *Pathfinder's* landing on the surface. "I knew that if everything else worked, the airbags would too."

Jennifer Harris, a flight director,

AP/JPL PHOTO (TOP); NASA PHOTOS (CENTER AND BOTTOM)

was one of the first to know that the airbags had worked. "We have D-A-T-A data," she announced jubilantly. Flight systems manager Brian Muirhead was even more excited. "It let us know it was on the surface and healthy within 3 minutes of landing."

Later, at about 7:30 pm Pacific time, *Pathfinder* returned the first crude image of the Martian landscape. It was markedly different from what *Viking 1* and *2* had recorded. In fact, some said it didn't look like Mars at all. There was, as the geologists had predicted, a dazzling array of different types and sizes of rocks. In the distance was the edge of a crater. Using it as a marker, the navigators determined that, because of unanticipated differences in atmospheric density, *Pathfinder* had landed just slightly outside of the predicted ellipse. The image also showed a partially tangled wheel, a problem that mission control quickly corrected.

With *Pathfinder* safely on Mars and the wheel freed, it was time to power up the rover and go for a ride.

One of the ways NASA was able to afford the gas money was to use as much off-the-shelf hardware as possible. Thus, the rover's eyes use the same technology as the imaging sensor in a $199 Kodak Digital Science DVC-300 camera. Its modem is a ruggedized version of a standard Motorola product.

However, when these parts were being put together, an unexpected problem arose. The rover didn't have enough room for wire and exceeded its weight limitations, explained Dale McKeeby, vice president of Pioneer Circuit. The NASA-JPL design team commissioned Pioneer to find a solution.

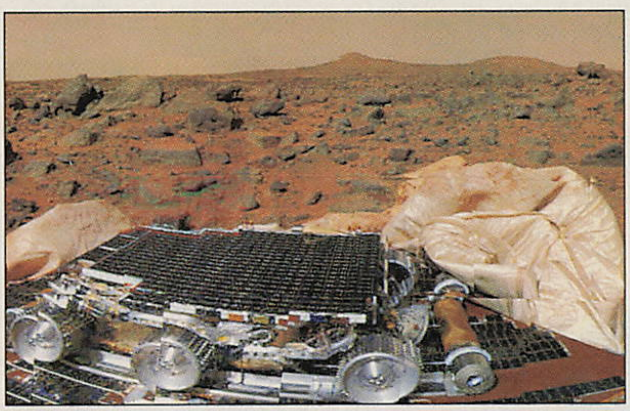
McKeeby proposed making a sandwich of flexible printed wiring boards (PWBs), like those used to connect circuit boards to the printing heads of many printers. The rover would need 5-, 26- and 30-layer sandwiches. The wiring was called rigid-flex.

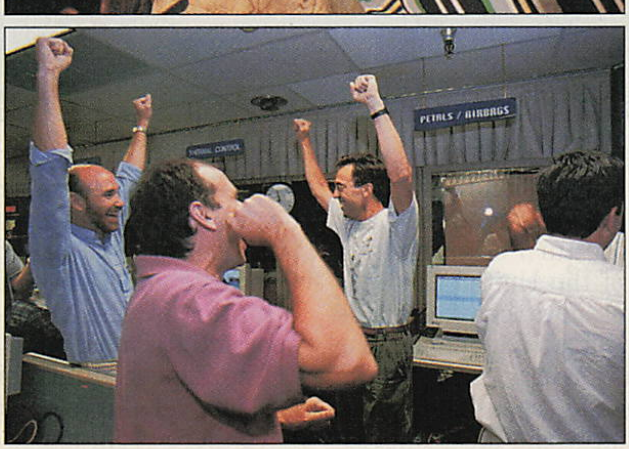
"PWBs of such high complexity had never before been used for a space flight application," McKeeby said after the landing. McKeeby claims that NASA was skeptical. "Whenever there was a communication glitch, the first thing that people would say was that it was the rigid-flex."

McKeeby had watched the landing from the cafeteria set aside for 200 mission-control family members and a select group of contractors. His eyes were glued to the monitor as *Sojourner* made her way slowly down the ramp, at last touching Martian soil. McKeeby let out a deep breath. "It was one of the most nerve-wracking 10 minutes of my life," he admitted.

But there would be other memorable moments of triumph, like when a dozen crew members marched into the auditorium adjoining the press room and, like parents showing off baby pictures, unreeled a 20-ft.-wide mosaic. Later, they would tack it to the rear wall and attach notes identifying unusual features. "Looks like barnacles on that one," I said. "There's a couch," exclaimed another person. "That looks like a bear," yet another blurted out.

It was a very un-NASA-like moment—spontaneous and filled with the sort of energy that the very spirited, very smart people who made *Pathfinder* possible have brought to the space program. Later, NASA administrator Dan Goldin walked into the press room carrying his grandson Zachary, who had been promised a cookie. Before helping his grandson collect the goody, Goldin proudly announced: "He's going to walk on Mars." PM





The anxiety was palpable when the first image showed *Sojourner's* rear wheel tangled in an airbag. Solutions were tested on a mock Martian surface. Once the wheel was freed, the crew in mission control celebrated.

AP/JPL PHOTO (TOP CENTER);
AP/KEVORK DJANSEZIAN PHOTOS (CENTER AND BOTTOM)

New Ca

Everywhere you look, it's style, performance and high technology.

BY DON CHAIKIN, Automotive Editor

● It's been a long century. We've seen mankind conquer the skies, travel through space and unite the world through television. And we've gained virtually limitless personal freedom at the turn of an ignition key. Most of the world and all of the United States is on motorized wheels. You'd think now that we're able to count the days until the turn of the millennium, the auto industry might take a breather, or at least slow its dizzying pace. Not so. The cars and trucks rolling out for the 1998 model year are simply the most impressive yet. From domestic and foreign makers there's a mind-boggling palette of new models. Here, listed alphabetically by maker, are the highlights.

Chrysler

Red-hot and running hard, No. 3 of the Big Three has some blockbuster new vehicles for '98. First and foremost are the brand-new, showstopping Chrysler Concorde and Dodge Intrepid sedans. Right on their bumper is the long-rumored Dodge Durango sport/utility vehicle.

The Concorde/Intrepid look is closer to a coupe than a sedan, yet Chrysler claims that the new cars actually have more room inside than the models they replace. They are also the first to carry new engines. The base models get a 24-valve dohc 2.7-liter 200-hp V6, while the Concorde LXi and Dodge ES get a 220-hp sohc

CHEVROLET CORVETTE CONVERTIBLE

24-valve 3.2-liter V6. Still to come is a 3.5-liter dohc 250-hp variant. While the Concorde and Intrepid are both longer than their predecessors, they're built on the same wheelbase as the old cars.

As for the Durango, it had to happen. The conversion of Dakota into an SUV was too natural a choice to pass up. As for power, the basic engine is a 175-hp 3.9-liter V6, with a 4-speed automatic and 4wd. Chrysler's 5.2-liter and 5.9-liter V8s are also available (2wd won't be, at first). Properly equipped, Durango can tow 7300 pounds.

Another natural was putting four doors on the Dodge Ram. Called Ram Quad Cab, the design offers two rear hinged doors and an extended cab.

Other news includes refinements to the Viper, including the more powerful 450-hp, 490-ft.-lb. engine from the GTS model in the RT/10 roadster, along with the coupe's doors, power windows and dual airbags. And finally, after being teased for close to a year by Plymouth, the Prowler makes its appearance.

Ford

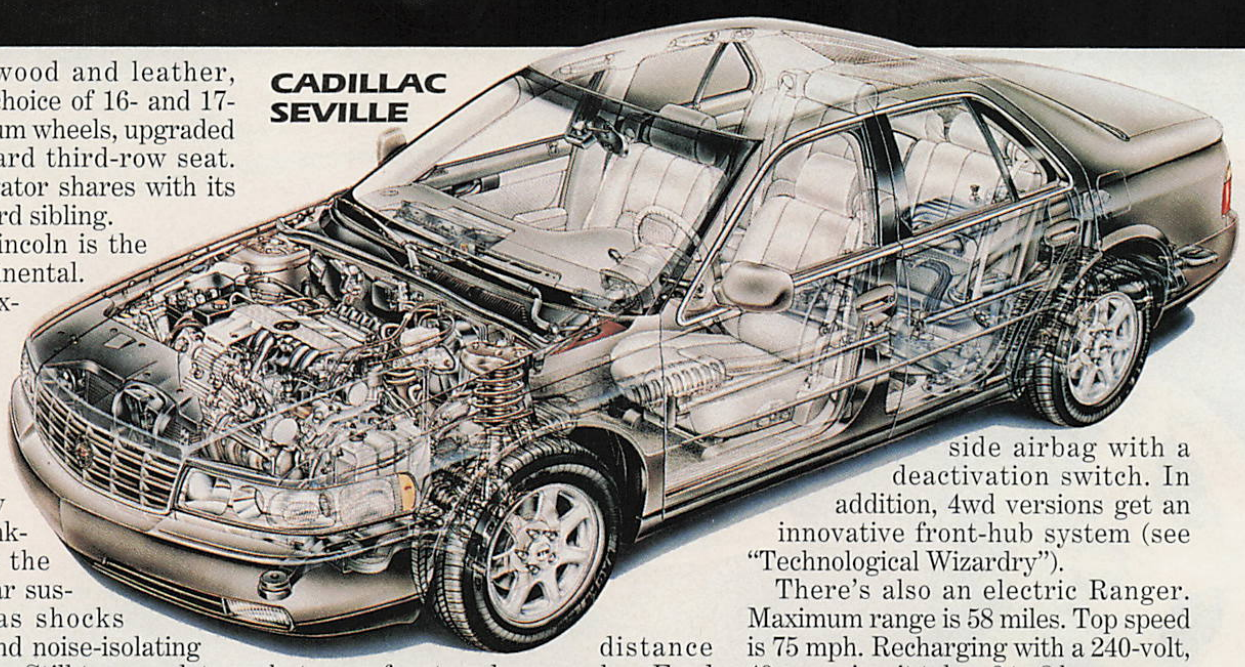
You won't find any '98 Thunderbird, Cougar, Aspire or Aerostar. However, one totally new nameplate takes its place in the ranks, the Lincoln Navigator. Clearly based on the Ford Expedition, Navigator's appoint-

CHRYSLER CONCORDE

ments include wood and leather, chrome grille, a choice of 16- and 17-in. forged-aluminum wheels, upgraded NVH and standard third-row seat. Otherwise, Navigator shares with its more common Ford sibling.

Also new at Lincoln is the look of the Continental. Changes to the exterior include a new fascia, hood and grille, repositioned windshield (its base is 5 in. farther forward) and new taillights and trunklid. Underneath the car is a luxury-car suspension with gas shocks front and rear, and noise-isolating front strut mounts. Still to come later in the year from Ford's luxury division is a brand-new Town Car.

For '98, Ford's Ranger pickup has new styling over its newly extended wheelbase. By adding 3.6 in. to the distance between front and rear axles, Ford was able to add 3 in. to the length of the cab. Under the new aluminum hood, the base engine grows from 2.3 to 2.5 liters, but it's still a Four. On the inside, there's now a passenger-side airbag with a deactivation switch. In addition, 4wd versions get an innovative front-hub system (see "Technological Wizardry").



CADILLAC SEVILLE

There's also an electric Ranger. Maximum range is 58 miles. Top speed is 75 mph. Recharging with a 240-volt, 40-amp circuit takes 6 to 8 hours.

General Motors

Following last year's blockbuster introductions of new minivans, a plethora of sedans and the fifth edi-

CHEVROLET PRIZM

PM PHOTO (TOP) BY BILL DELANEY

tion of America's sports car, GM is refining what it has. Chief among those refinements is the spread of the availability of the futureworld OnStar system. Last year it was a Cadillac exclusive. This year it does more and does it for more people.

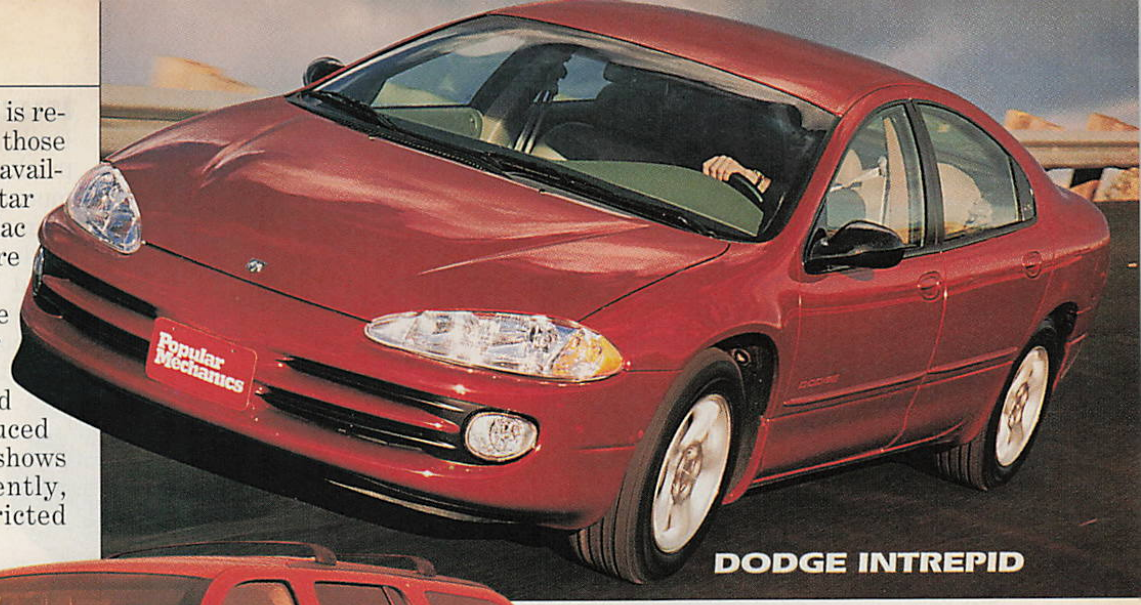
One refinement that cannot be ignored is the glorious roadster version of the new Corvette. Sharing the new engine and chassis of the recently introduced coupe, the open-top Corvette shows what traveling fast, competently, stylishly and with an unrestricted view is like.

Other news from Chevrolet is the proliferation of that name and its familiar bowtie. Gone is the Geo nameplate—from now on the vehicles that were sold as Geos are once again Chevrolets. And for '98, one of them is new. The Prizm, like its soul mate Toyota Corolla, gets a new, lighter 120-hp 1.8-liter 4-cylinder engine, a stiffer body structure and available side-impact airbags as well as frontal ones—a rarity in this market segment.

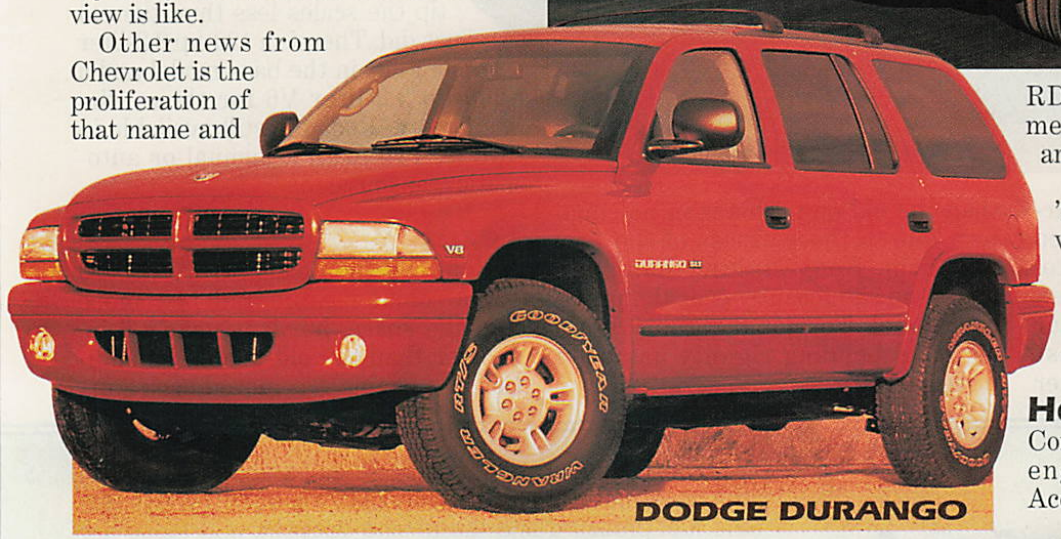
At Buick, the news is that plain old new-car buyers won't be able to get a new Skylark, as that car is now only available to fleet buyers.

Cadillac is saving its biggest news, an all-new Seville, for another month or so. But we do know that the car will be a rolling engineering tour de force, right down to front seats that adjust themselves to their occupants' positions over the course of a drive (see "Smart Seats"). Also, Cadillac will offer the Radio Data System (RDS). More than simply an emergency interruption in your regular radio broadcast, RDS will be able to give you pager messages, the latest traffic reports and even stock quotes.

Other developments at GM for '98 include the spawning of a V6 version of the Northstar V8 engine. With a displacement of 3.5 liters, the V6 produces 215 hp. The engine will appear down the road in Oldsmobile Intrigue.

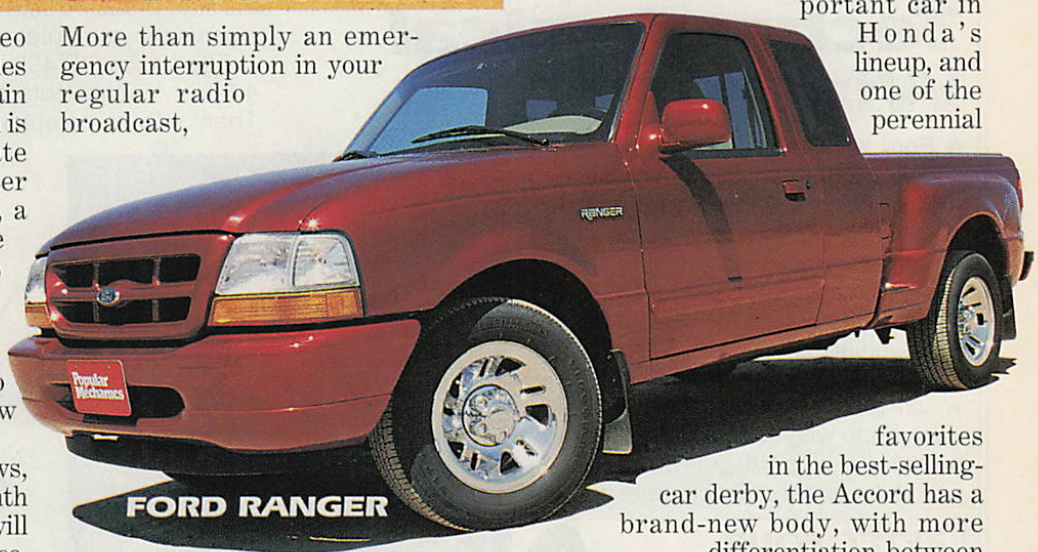


DODGE INTREPID

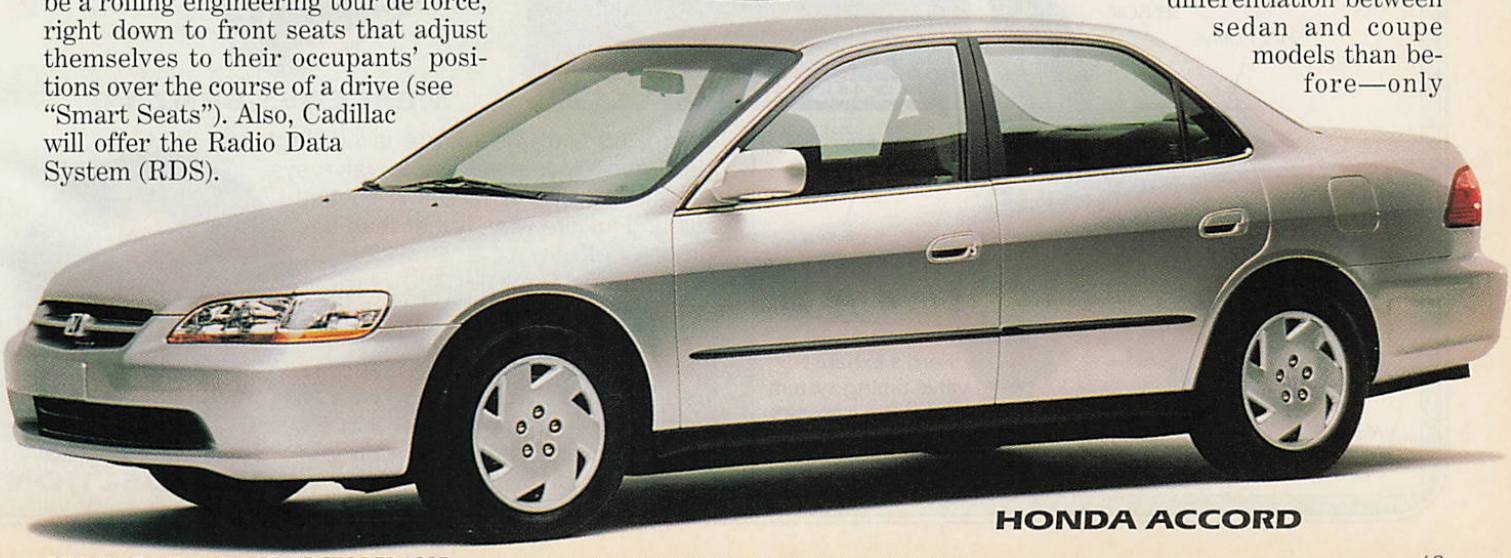

DODGE DURANGO

Honda

Complete with new made-in-America engines, there's a spanking new Accord for '98. Clearly the most important car in Honda's lineup, and one of the perennial favorites in the best-selling-car derby, the Accord has a brand-new body, with more differentiation between sedan and coupe models than before—only



FORD RANGER


HONDA ACCORD

PM PHOTOS (TOP) BY BILL DELANEY, (CENTER, RIGHT) BY CLIFF GROMER

ISUZU RODEO

Isuzu

Built in Lafayette, Indiana, like its predecessor, the new Rodeo is lighter, more powerful and more aerodynamic than the one it replaces. Although the Rodeo's wheelbase has been shortened by 2 in. to accommodate the spare tire beneath the vehicle (a no-cost option), there's more room inside. Most of it is in the cargo area. Complementing the shorter wheelbase is a 2.5-in. wider track. Besides a new frame that's 50 pounds less than the old one, the new engines also tip the scales less than the old ones did. There's a 129-hp 2.2-liter dohc Four in the base model and a 205-hp 3.2-liter V6 for those who want more. Rodeo is still available in 2wd or 4wd, with a manual or automatic transmission.

Lexus

New for '98, the Lexus GS 300/GS 400 has a roomier cabin and 14% more luggage space, but it is nearly 6 in. shorter than the old model. In addition, the engine was moved back 2 in.,

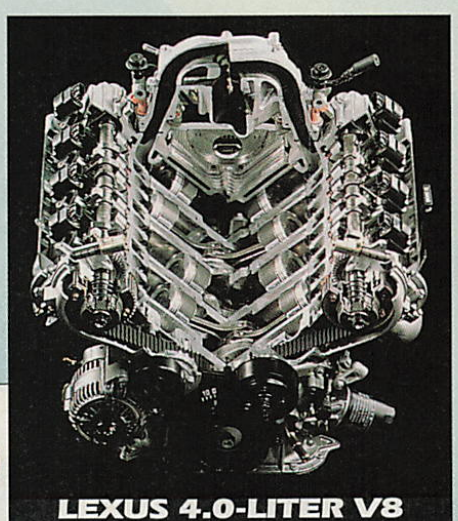
their headlights are the same. The Accord's new platform boasts a refined suspension. There's also a new automatic transmission to go with the new engines. There's a new 2.3-liter Four and a 3.0-liter V6. Perhaps most amazingly, the new Accord is quieter than the old one. This is in no small part due to the stiffness of the new platform. Body rigidity has been increased significantly over the previous model. Torsional rigidity is up 40% and bending rigidity has been increased 60%.

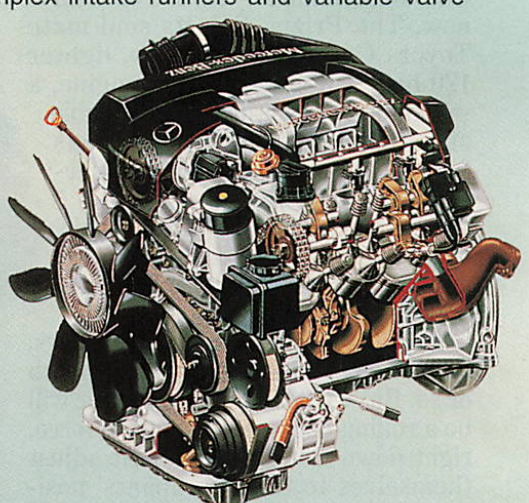
Trend
Technological Wizardry

● Ford engineers have developed a variable exhaust-valve timing system for the Zetec 2.0-liter Four. The variable ranges from zero change at idle to 60° of valve overlap at higher speeds and eliminates the need for EGR.

Ford has also developed a returnless fuel-injection system. This means no hot fuel flowing back to the tank, which reduces vapors (this has also been done with trucks). The '98 Continental 4.6-liter V8 gets it, thanks in part to an enhanced computer system with a 33% faster clock speed. A dual-function sensor for the computer sits atop the fuel rail. The sensor measures the fuel pressure and the engine vacuum, and these are signals the computer uses to control fuel-pump voltage.

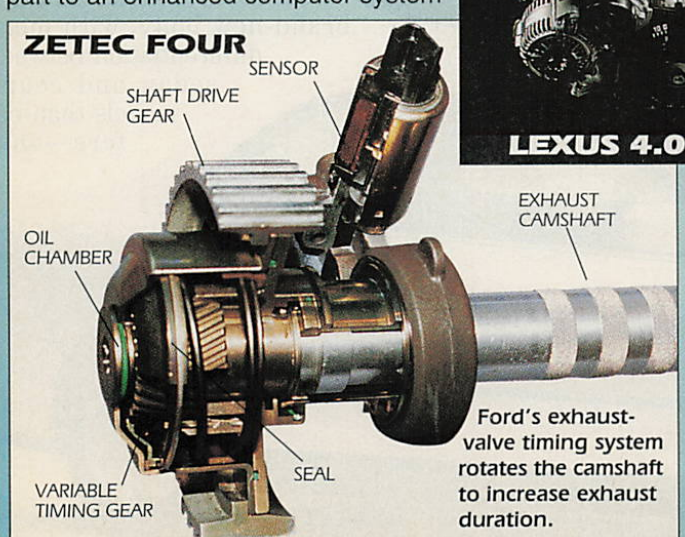
The Lexus GS 400 is powered by an all-aluminum dohc 4.0-liter V8 that puts out 300 hp and 310 ft.-lb. of torque. Thanks to its complex intake runners and variable valve timing, 80% of the torque is available at 1800 rpm. Toyota's variable valve system alters valve overlap in a continuous and infinite way, rather than being on or off.


LEXUS 4.0-LITER V8


MERCEDES-BENZ V6

Mercedes-Benz ML320 carries the company's first V6, a 90° all-aluminum engine with a balance shaft. Its combustion chamber also is a first: 3-valve (two intakes) with two spark plugs, an innovation that's combined with ultralong spiral runners in a barrel-type intake manifold.

RETURNLESS FUEL INJECTION



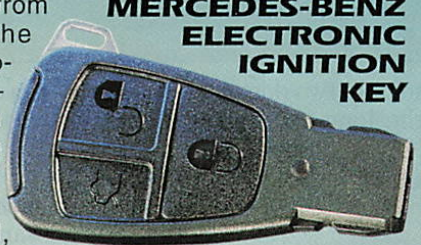
Ford's exhaust-valve timing system rotates the camshaft to increase exhaust duration.

the fuel tank wraps around the driveshaft and sits under the rear seat, and the rear suspension is a compact double-wishbone design. Put it together and it makes for responsive handling. Then wrap it up in a sleek body with short overhangs and a Cd of 0.29 and offer a 225-hp 3.0-liter Six in the GS 300 and a 4.0-liter V8 in the GS 400. Both cars get a new 5-speed automatic, with the GS 400 getting "E-shift," a manually shifted automatic. Both also get a new stability system called Vehicle Skid Control (VSC).

Mercedes-Benz

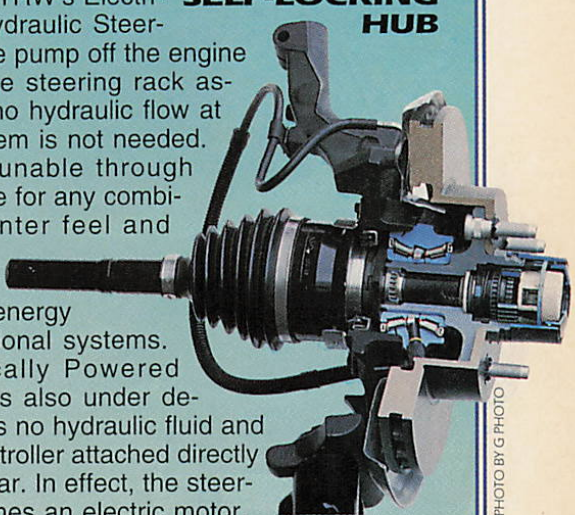
Made in Alabama, the Mercedes-Benz ML320 offers body-on-frame construction, 4-wheel independent suspension, 4-channel ABS, dual front and side airbags, and a brand-new 215-hp V6 engine. With full-time 4-

Other innovations from Mercedes include the key—soon to be introduced on the CLK—which is actually an extension flange on the current remote transmitter. It can be inserted and turned, but it's going into an electronic switch, not a key slot. The switch triggers a data exchange between the remote and the computer to unlock the steering column and gives an electronic okay for the car to start. Mercedes also has electronic brake assist, which senses how the driver hits the brake pedal. If the computer determines that the braking is a panic stop, it uses the car's antilock brake system and automatically applies full braking pressure.



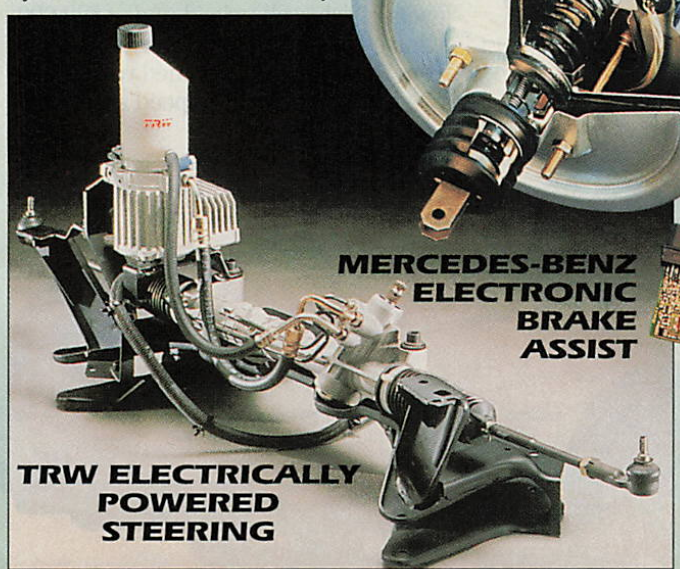
MERCEDES-BENZ ELECTRONIC IGNITION KEY

Almost here is TRW's Electrically Powered Hydraulic Steering. This takes the pump off the engine and puts it on the steering rack assembly. There's no hydraulic flow at all when the system is not needed. The system is tunable through controller software for any combination of on-center feel and steering assist. Plus it can save up to 85% of the energy used by conventional systems. TRW's Electrically Powered Steering (EPS) is also under development. It uses no hydraulic fluid and operates by a controller attached directly to the steering gear. In effect, the steering system becomes an electric motor, moving the steering arms in and out according to steering wheel input, the torque sensor, the vehicle speed sensor, the steering position sensor and the controller software.



FORD RANGER SELF-LOCKING HUB

PM PHOTO BY G PHOTO



MERCEDES-BENZ ELECTRONIC BRAKE ASSIST

TRW ELECTRICALLY POWERED STEERING

For 1998, the Ford Ranger gets a true shift-on-the-fly with a disconnect at each wheel hub. The mechanism that actually engages or disengages each axle still is a dog clutch, but there's one supercompact actuator tucked into a plastic cap in each hub, with a novel 2-stage vacuum solenoid. The solenoid is a "pulsating" design controlled by the powertrain computer, so that the solenoid delivers either of two amounts of vacuum to a diaphragm unit in the hub. At high vacuum, the plastic cap moves far enough to operate a spring-loaded mechanism and the dog clutch to lock the wheel hub to the axle shaft. At low vacuum, the cap moves to retract the clutch, so the hub/wheel assembly can spin on its own (2wd).

MERCEDES-BENZ CLK

wheel drive with normal 50/50 front/rear torque and Mercedes' 4ETS electronic traction system, the ML320 offers amazing off-road capabilities. It also offers on-road performance one expects from any passenger car named Mercedes. The ML320 has the longest wheelbase in the class at 111 in., with an overall length of 180.6 in. It's rated at 85.4 cu. ft. of cargo space, also the most of its class. Priced right at Explorer and Grand Cherokee (under $40,000), the ML320 is sure to devour some Range Rovers along the way, too. This year also

MERCEDES-BENZ ML320

LINCOLN NAVIGATOR

and only two doors, the long-awaited CLK is also here for '98. Based on a C-Class chassis, it has E-Class-inspired looks and drivetrain.

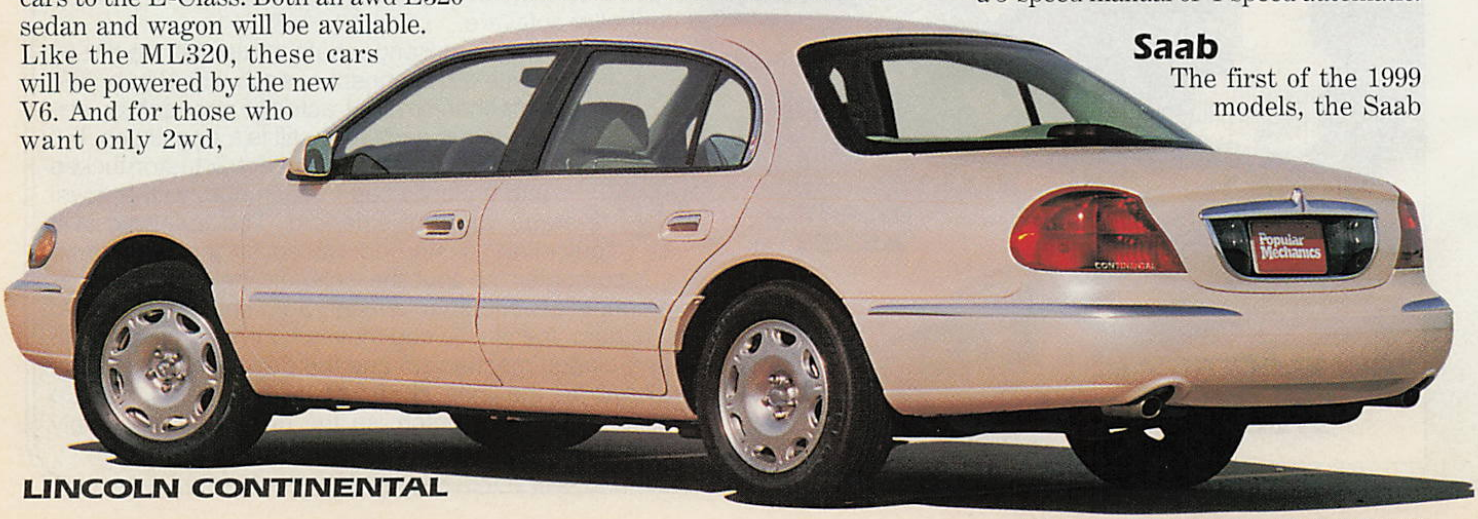
marks the return of awd cars to the E-Class. Both an awd E320 sedan and wagon will be available. Like the ML320, these cars will be powered by the new V6. And for those who want only 2wd,

Nissan

Completely redesigned on the outside, the 1998 Nissan Altima is bigger than its forebear. The new car has a 1.6-in.-wider track, a 3.7-in. increase in length and 1.7-in.-greater width. These changes result in more front- and rear-seat legroom. Nissan's main aim in redoing the Altima was to increase value while holding the line on prices. Increased value includes a 20% stronger body and noticeably lower noise levels. As before, there are four levels of trim, all priced under $20,000. All use the 150-hp, 2.4-liter dohc Four from the old model, teamed with either a 5-speed manual or 4-speed automatic.

Saab

The first of the 1999 models, the Saab



LINCOLN CONTINENTAL

PM PHOTO BY G PHOTO (BOTTOM)

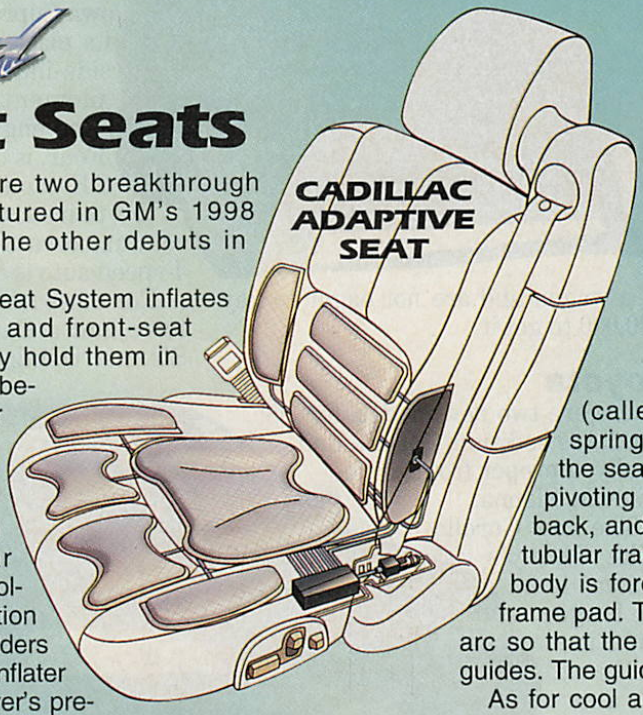
NISSAN ALTIMA

9-5, replaces the 9000 this spring. The exterior styling of the 9-5 borrows enough styling cues from the 900 and 9000 to be instantly recognizable to even non-Saab-ites, while still refreshingly contemporary enough to attract, well, even non-Saab-ites. The only real Saab-ism is the floor-mounted ignition key. There's a choice of three engines. There are two Fours: a 150-hp normally aspirated one and a 170-hp turbocharged 2.3-liter version. Then there's a very smooth and torquey 200-hp 3.0-liter V6 that's turbocharged by only one bank of exhaust ports. Safety features include seat-mounted side airbags and considerable engineering of the chassis and body structure for crash safety. See "Smart Seats" for more details about the car's seats.

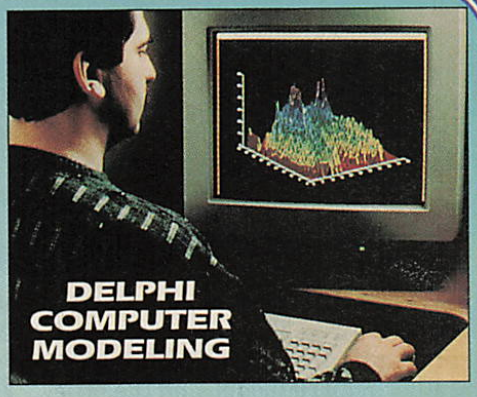
Trend

Smart Seats

● For '98, there are two breakthrough seats. One is featured in GM's 1998 Seville STS and the other debuts in Saab's 9-5.


CADILLAC ADAPTIVE SEAT

GM's Adaptive Seat System inflates around the driver and front-seat passenger to gently hold them in place. Sandwiched between the leather surface and support padding are 10 air bladders placed around the bottom cushions, lumbar supports and side bolsters. After the ignition is turned on, the bladders inflate. The lumbar inflater will adjust to the driver's preferred pressure. The seat automatically checks the pressure settings every 4 minutes. As you change your position while you drive, the inflation of the appropriate bladders is adjusted, thanks to readings of sensors in each bladder.


DELPHI COMPUTER MODELING

Adaptive seat technology was developed with the help of one of the newest tools in the search for car ride comfort. It's a meter used by Delphi that measures the way you spread your bottom across the car seat. An electronic mat that fits over the seat's cushions holds 3600 contact points, or sensors. In lab tests, the weight your bottom puts on the seat is recorded by a computer, then displayed on a videoscreen.

Saab's 9-5 boasts front seats that may eliminate whiplash injuries and have ventilating fans built into the cushions. To prevent whiplash, the headrests have a mechanical device built into the seatback. A tubular frame and a pad (called a pressure plate) is connected to spring-loaded pivot links near the bottom of the seatback. The tubes go through guides in a pivoting crossmember near the top of the seatback, and to a padded headrest on the top of the tubular frame. If the car is rear-ended, the driver's body is forced back, which pushes on the tubular frame pad. The bottom of the frame pivots back in an arc so that the frame tubes slide up the crossmember guides. The guide tilts forward in response.

As for cool and dry conditions, the seats have perforated leather upholstery that hides very thin electrical fans—one in the seat bottom, one in the seatback. The 3-speed fans pull air from between the driver's body and the upholstery, expelling it out beneath the seat.

SAAB 9-5 ACTIVE HEAD RESTRAINT

SAAB 9-5 VENTILATED SEAT

Subaru

First, for '98 there's the Impreza-based Forester. Built on a short 99.4-in. wheelbase, with an overall length of 175.2 in., it's only 3 in. longer than an Impreza sedan, but with an inch more ground clearance than the Outback Sport at 7.5 in. It uses the same engine as the Legacy Outback, a 165-hp 2.5-liter Four. A 5-speed manual is standard, a 4-speed overdrive automatic optional.

Second, Subaru is offering the Impreza 2.5 RS, which echoes the performance of the Subaru WRX rally sedan. The 2.5 RS package runs to 16 items, including gold 7x16-in. alloy wheels with 205/55R-16 tires. The 165-horsepower engine pulls less weight than with any other Subaru model, and the little car scoots.

SUBARU IMPREZA 2.5 RS

Suzuki

In case you haven't noticed, Suzuki has been growing. Sales of the Esteem subcompact were up more than 30% last year. And for '98 they should be up more, thanks to the addition of more dealers and another model, the Esteem Wagon. Powered by a 95-hp 1.6-liter Four and either a 5-speed manual or 4-speed automatic, the little wagon is looking to gain sales from young families who need the versatility of a wagon and are not eager to pay $20,000 to get it.

SAAB 9-5

Toyota

There are two new models for '98: the latest-edition Corolla and, finally, a proper front-drive minivan, Sienna.

The new Corolla (like Chevy's Prizm) is 2 in. longer and 1 in. taller than its predecessor, yet it sits on the same wheelbase. Its new body is extremely aerodynamic for the market segment. With a Cd of 0.31, it's slipperier than Toyota's own Supra. Also exceptional for its place in the market are the side-impact airbags that complement its dual front ones. One engine, a 120-hp 1.8-liter Four, is offered. In the VE and CE models, the engine can be paired with either a 5-speed manual or a 3-speed automatic. A 4-speed auto is only in the LE.

For those folks who wish they could have had a Camry minivan, here's Sienna. Using Camry's front-drive chassis, with its 194-hp V6 and 4-speed automatic transmission, Sienna offers more power than most of its competitors. It also offers an optional driver's-side sliding door to complement the one on the passenger side. It will soon also offer a power sliding passenger door. Standard equipment includes ABS, front and side-impact airbags and a tire pressure warning system.

Corolla and its Chevy near-twin, Prizm, are built in California, while Sienna is built in Kentucky. PM

TOYOTA COROLLA

TOYOTA SIENNA

PM PHOTOS BY SCOTT DAHLQUIST (TOP), AND BY DAVID DEWHURST (CENTER, RIGHT)

Trend

Convergence Of Cars And Trucks

SUBARU FORESTER

● It's a sheep in wolf's clothing.

Honda's hot new CR-V looks rugged, durable and ready to challenge the roughest, toughest sport/utility vehicles on—or off—the road. But looks can be deceiving. Put CR-V up on a hoist and you'll find its go-anywhere exterior clads the same chassis as the mundane Civic sedan. So what?

Light trucks are the hottest thing on the road, part of a "crossover boom" reshaping the automotive landscape. SUV sales are up 30-fold since the early 1980s, buoyed by their utility, versatility and machismo. Shift into 4-wheel drive and nothing stands in your way. Yet studies show that less than 5% of sport/utes are ever driven down anything rougher than a gravel road.

HONDA CR-V

The traditional SUV body is mounted on a trucklike steel frame. It's hundreds of pounds heavier than a comparably sized passenger car's unibody construction. That translates into lower fuel economy, more labor-intensive assembly operations and higher retail prices. Trucks also tend to be rougher riding and less nimble than passenger cars, and more prone to rolling over under aggressive driving. So why not blend the best of both worlds?

That's the idea behind the CR-V and a growing list of car/truck hybrids that are taking the market by storm. And the CR-V isn't the only hybrid success story. With actor Paul Hogan as spokesman, Subaru's "sport/utility wagon," the Legacy Outback, is flying out of showrooms faster than you can say "Crocodile Dundee." Subaru adds another hybrid, the Forester, to its lineup this fall.

Toyota's RAV4 has been winning rave reviews—and plenty of buyers. Sales hit 90,000 last year, nearly triple the automaker's original forecast. Significantly, 60% of RAV4 buyers are female, three times the norm in the traditional sport/ute segment. Toyota is so hot on car/truck hybrids that it has a range of new models under development. Looking like a downsized version of the Lexus LX 450 sport/ute, the SLV concept car is a mix of beauty and brawn. Its 17-in. wheels seem ready to claw their way up the side of Pike's Peak. But under the skin, SLV shares platforms with the new ES 300 sedan. It features an all-new, all-aluminum 3.0-liter V6 and a fully independent suspension, front and rear, rather than the solid axle suspension normally used in truck-based SUVs. And there's rack-and-pinion steering, another rarity among sport/utes. Look for a production version of the SLV to hit the market in mid-1998.

MERCEDES ML320

Mercedes-Benz is bucking the trend with its all-new ML320. It's car-sized, but its basis is its own—no existing car, no existing truck.

There are plenty of other hybrids wending their way from concept to customer. Eventually, car/truck hybrids could make up a third of the total U.S. light-truck market, which would be 2.5 million units a year, predicts auto analyst Joe Phillippi. Perhaps one will even find its way into your own driveway.

—Paul Eisenstein

TOYOTA RAV4

...AND BEYOND 2000

The world's automakers are already working on the next millennium.

BY DON CHAIKIN, Automotive Editor

● Hordes of computer hackers and self-proclaimed prophets the world over are predicting the end of civilization as we know it when clocks strike midnight on Dec. 31, 1999. Carmakers, however, are betting billions that we'll still be here the next day, here and clamoring to drive the new '00s.

In fact, the carmakers are already testing the basics of the designs of cars for the post-year-2000 period. Those designs are cloaked in the concept vehicles seen at auto shows and unseen beneath their shrouds of armed secrecy at proving grounds. Here's the cream of the future car crop.

MERCURY MC4

A smaller, secondary rear-hinged door that mates with a regular, front-hinged one makes for a large opening and E-Z in, E-Z out of the back seat of this forward-thinking Mercury sports coupe. The secondary doors allow the use of smaller front doors so those in front can also get in and out easily in tight parking spaces. The lack of a B pillar between the front and rear doors allows for a capacious opening when both doors are open.

Purists may argue that, by definition, anything with four doors—no matter how they're hinged—cannot be a coupe. Designers and engineers at Ford Motor Co. disagree. In fact, if the MC4 is a harbinger of coupes to come, it may also have a gullwing-type rear hatch, a video imaging system for improved rear visibility, a GPS-based navigation system, and a speed control that adjusts speed as it overtakes traffic.

PM PHOTO (TOP) BY BILL DELANEY

DODGE COPPERHEAD

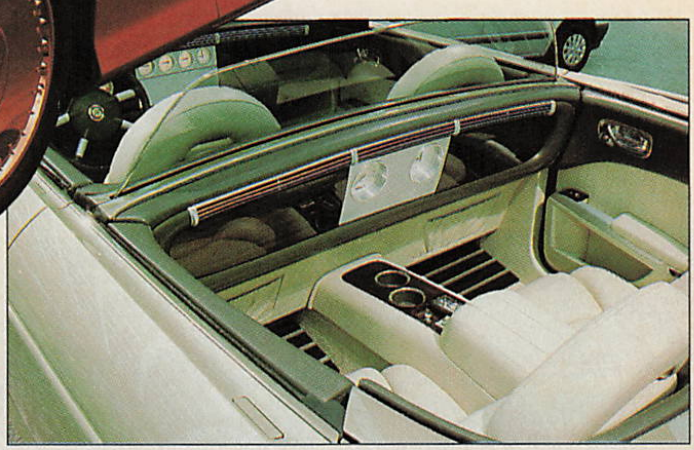
When considering *any* concept car from Chrysler, remember that both the Viper and the Prowler were show cars not that long ago.

Copperhead is essentially a tamed, somewhat leaner Viper. It's 8 in. shorter and 3 in. narrower. In place of Viper's megatorque V10, Copperhead has a 2.7-liter V6 designed for the company's newest sedans. The rear wheels are as far away from the front ones as they can be while still being connected to the same chassis. Copperhead's wheelbase is more than a foot longer than the Viper's.

CHRYSLER PHAETON

By looking back 50 years, Chrysler designers have created a vision of the future luxury car. A true dual-cowl tourer in the classic sense, the open-top Phaeton has separate windscreens for front and rear passengers (the rear ones are retractable). Inspiration for the Phaeton came from Chrysler's 1940 Newport parade car, which was used for parading the rich and famous of the era down the country's boulevards—and pacing the 1941 Indy 500.

Phaeton has separate sound systems, climate controls and gauge packages in both compartments. A rear-mounted speedometer and tach give back-seat drivers accurate ammo for driving criticisms. True to the car's luxurious intent, all seats are leather and both compartments are trimmed in leather, Zebrano wood and satin-finish metal.



Phaeton cuts an imposing profile—it's 215 in. long and sits on a 132-in. wheelbase. That's Suburban territory. However, unlike any Suburban, Phaeton is powered by a 425-hp 48-valve 5.4-liter V12. And its suspension is based on a Dodge Viper's—just in case you really want to give those gauge-watching back seaters something to really howl about.

PM PHOTOS BY BILL DELANEY (CENTER) AND G PHOTO (BOTTOM)

PLYMOUTH PRONTO

Plymouth's Pronto clearly is the spiritual successor to Citroën's 2CV "Deux Chevaux."

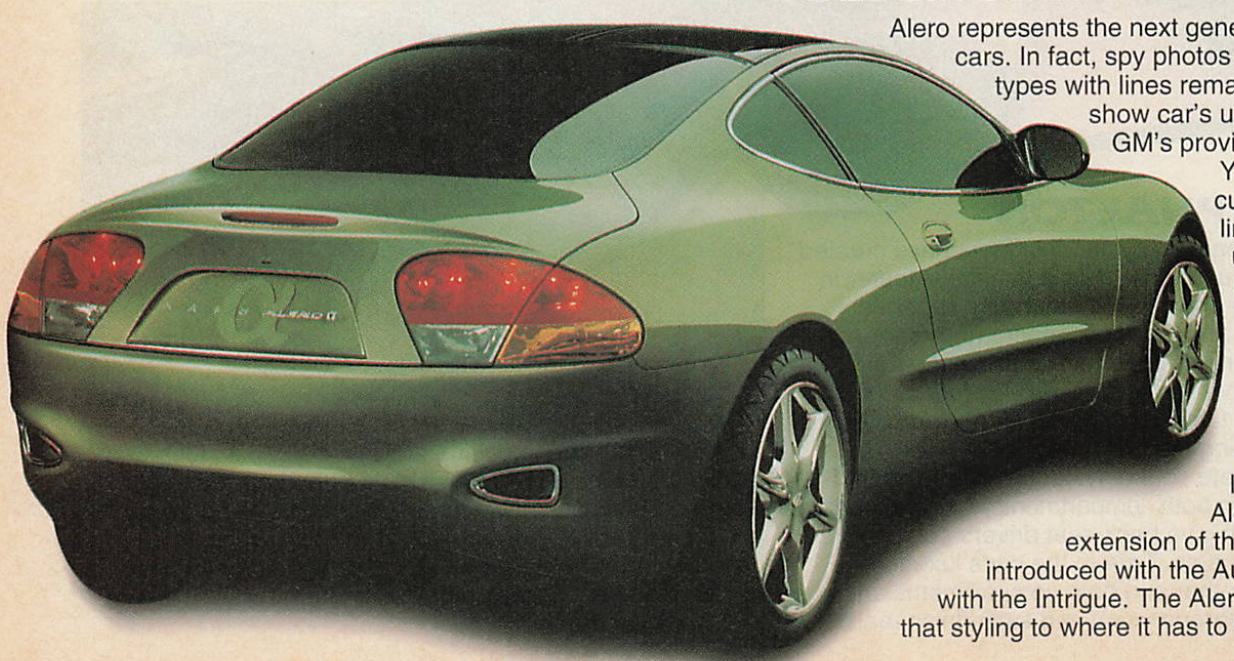
With its tall height, short length, four doors, four seats, continuously flowing arc-shaped and folding cloth sunroof, the Pronto is ready to do battle on urban byways. Pronto embodies more than Chrysler's idea of tomorrow's subcompact. It's also meant to explore future manufacturing possibilities. In fact, while the existing Pronto is made using traditional materials and time-honored methods, this car tests the feasibility of building a car primarily of injection-molded plastic.

KARMANN OPEN VIEW

You can't tell just by looking at the locomotivelike Open View, but beneath that mass of metal is a Ford Explorer. Its most intriguing aspect, however, is its sliding/folding glass sunroof. The roof is comprised of three panels that span from nearly the top edge of the windshield to the top of the rear hatch. At the touch of a button, the panels fold, retract and automatically stow neatly behind the rear seats. The mechanism that operates the glass roof is similar to the one Karmann developed for the Mercedes-Benz SLK.

Karmann's designers integrated the front fenders longitudinally over the doors. Those doors hide integral steps to allow ingress and egress without the need of a running board.

OLDSMOBILE ALERO



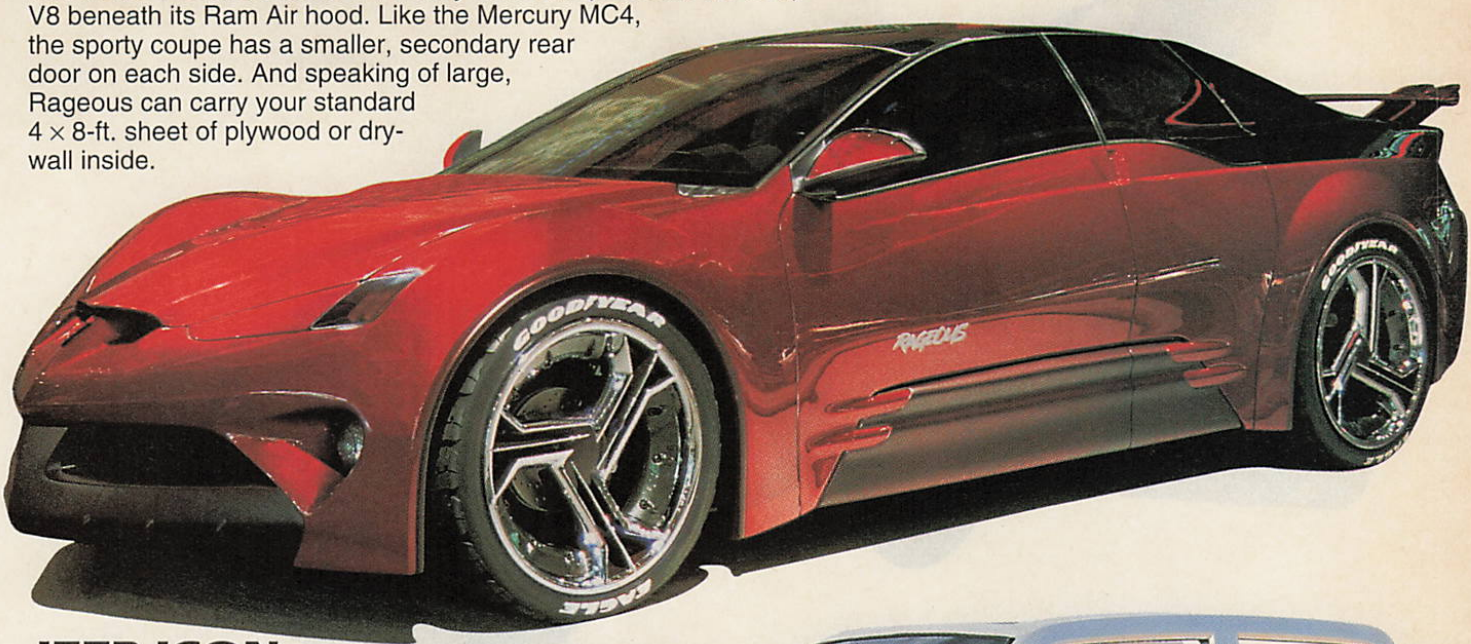
Alero represents the next generation of small family cars. In fact, spy photos have revealed prototypes with lines remarkably similar to this show car's undergoing testing at GM's proving grounds.

Yes, the swoopy, curvaceous, lithe body lines remained fairly unchanged. And sure, the short overhangs have grown a bit in the name of safety regulations, but the car still boasts a long wheelbase (113 in.) for its length (182 in.). The Alero looks like the next extension of the design that Olds introduced with the Aurora and continued with the Intrigue. The Alero, however, takes that styling to where it has to be—the next century.

PM PHOTO (TOP) BY BILL DELANEY

PONTIAC RAGEOUS

We don't know about you, but we've felt that recent Pontiacs lacked that in-your-face-and-what-are-you-going-to-do-about-it? look that helped make Pontiac the bad boy of GM's stable. Well, if the Rageous is a harbinger of what's cooking, it looks like Pontiac's back. This nasty red concept boasts a 315-hp V8 beneath its Ram Air hood. Like the Mercury MC4, the sporty coupe has a smaller, secondary rear door on each side. And speaking of large, Rageous can carry your standard 4 × 8-ft. sheet of plywood or drywall inside.



JEEP ICON

As long as Chrysler Corp. is the keeper of the Jeep flame, it should continue to burn—well into the next century and far, far off-road. That's the message sent by the Icon.

With a fully independent suspension featuring 10 in. of wheel travel, 4-wheel disc brakes and 19-in. tires, the Icon is armed and ready. Reduced length, less overhang and a wider track all contribute to stability, ability and tough looks.

Icon keeps Wrangler's beloved styling touches: exposed door hinges, classic grille, rollcage and folding windshield.

JEEP DAKAR

Peel off the roof rack, remove the big driving lights, ditch the winch and the spare tire up on the roof, and what's left? How about a 4-door Jeep Wrangler? With the booming success of small 4-door sport/utility vehicles—led by Toyota's RAV4 and Honda's CR-V—Jeep has been left betwixt and between. The company's Cherokee and Grand Cherokee models are too large and expensive to compete, while the cute-yet-rugged-and-really-did-write-the-book Wrangler has been left by the 2-door wayside.

Enter the Dakar.

With an overall length that's a few inches longer than a 4-door RAV4 and nearly a foot shorter than a CR-V and sitting on a longer wheelbase than either, the Dakar is sized right to compete. **PM**

PM PHOTOS BY G PHOTO (TOP) AND BILL DELANEY (CENTER AND BOTTOM)

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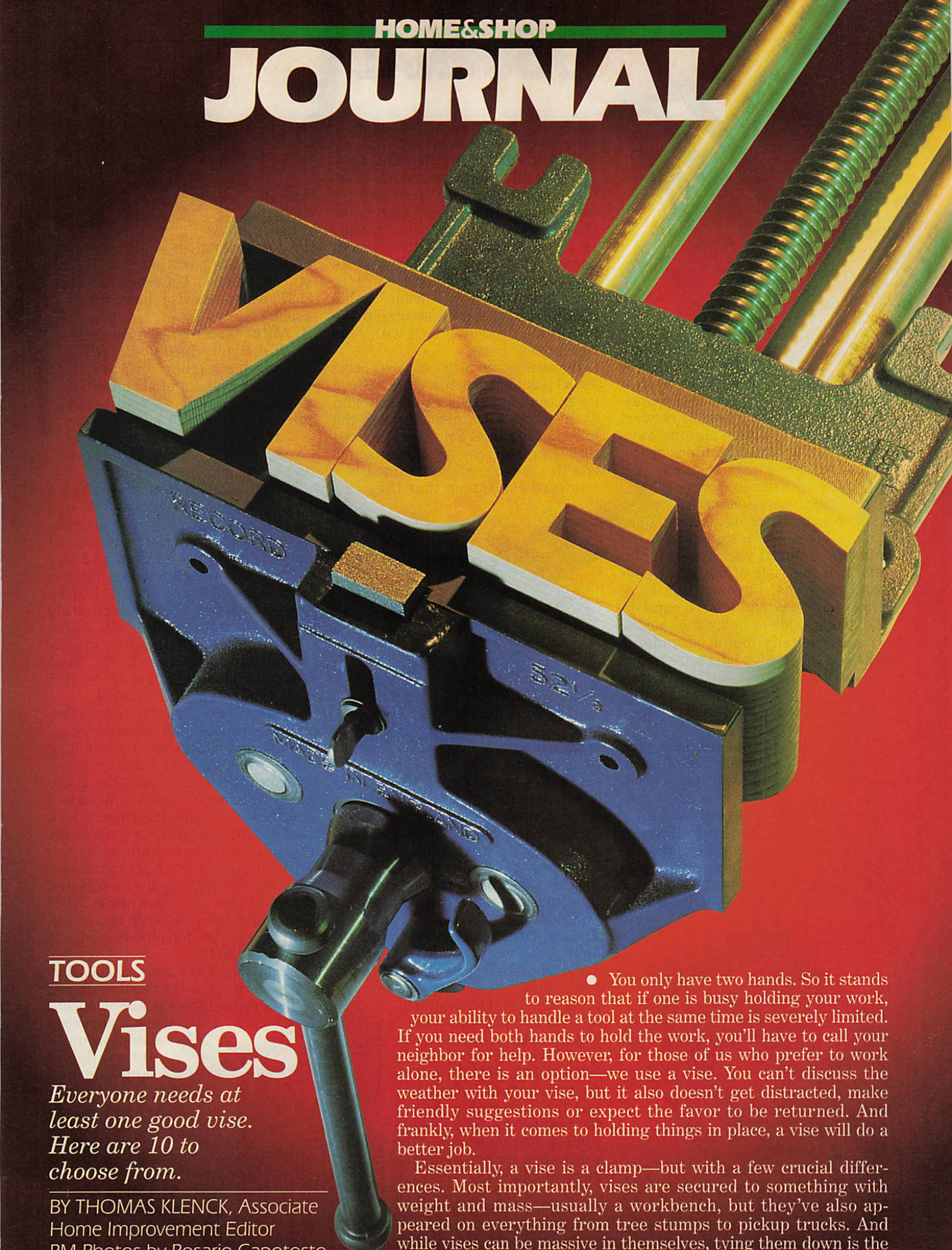


TOOLS

Vises

Everyone needs at least one good vise. Here are 10 to choose from.

BY THOMAS KLENCK, Associate Home Improvement Editor
PM Photos by Rosario Capotosto

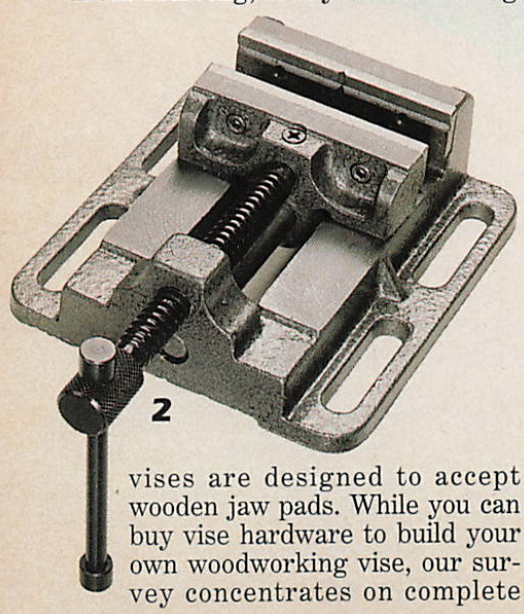
● You only have two hands. So it stands to reason that if one is busy holding your work, your ability to handle a tool at the same time is severely limited. If you need both hands to hold the work, you'll have to call your neighbor for help. However, for those of us who prefer to work alone, there is an option—we use a vise. You can't discuss the weather with your vise, but it also doesn't get distracted, make friendly suggestions or expect the favor to be returned. And frankly, when it comes to holding things in place, a vise will do a better job.

Essentially, a vise is a clamp—but with a few crucial differences. Most importantly, vises are secured to something with weight and mass—usually a workbench, but they've also appeared on everything from tree stumps to pickup trucks. And while vises can be massive in themselves, tying them down is the best way to ensure rock-solid stability.

Like most clamps, vises rely on a screw to apply pressure. However, where clamps have relatively small contact areas, vises have robust jaws, often with textured or specially shaped faces that enhance gripping ability.

Vises are designed to suit the material you're working with and the scale of the job. Woodworking vises, for example, have broad jaw faces and a large capacity for holding wide or bulky workpieces. They're usually mounted under a bench so the jaw top edges are nearly flush with the work surface. Metalworking and utility vises are typically mounted on top of the bench and they have narrower jaws.

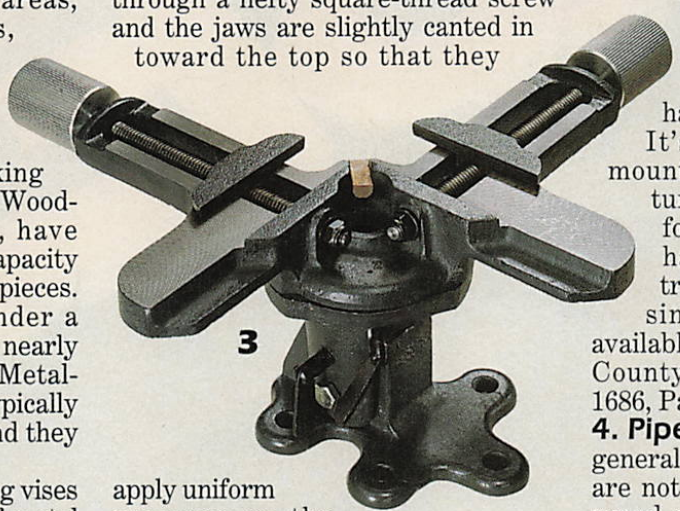
In days gone by, woodworking vises were made with a minimum of metal hardware—even the screw was wood. Now, many woodworking vises feature cast-iron construction with a steel screw mechanism, although lighter alloys have been introduced to replace the cast iron without sacrificing strength. To protect the work from marring, many woodworking



vises are designed to accept wooden jaw pads. While you can buy vise hardware to build your own woodworking vise, our survey concentrates on complete units that only need to be bolted, screwed or clamped in place.

1. Woodworking vise—This basic design is offered by several manufacturers and it's the standard unit for cabinetmaking and joinery. The model shown has 9-in. jaws that open as wide as 13 in. Tapped holes in the jaws permit securing wooden jaw faces that prevent marring. Cast-iron construction makes for a strong, stable platform and the vise is secured to the underside of your bench with four lagscrews or bolts.

Because of its large capacity, this model is equipped with a quick-release lever that bypasses the screw and enables fast adjustment through the full opening range. Pressure is applied through a hefty square-thread screw and the jaws are slightly canted in toward the top so that they



apply uniform pressure as the screw is tightened. A retractable dog permits holding large workpieces on the benchtop. The Record 52½ D (shown) costs about $170 from Constantine, 2050 Eastchester Rd., Bronx, NY 10461. Smaller models and versions without the quick-release feature are also available.

2. Drill-press vise—Safe, accurate drill-press work requires that the workpiece be securely clamped to the table. While you could use a clamp to do the job, the standard solution is a drill-press vise. Unlike other vises, this one isn't permanently fastened in place. It's secured to the drill-press table with bolts that fit in the table's slots so the vise can be positioned to suit the size and shape of the workpiece, or the requirements of the job.

For boring a series of aligned holes, milling slots and accurate pipe positioning, the basic drill-press vise is available on a screw-activated cross slide.

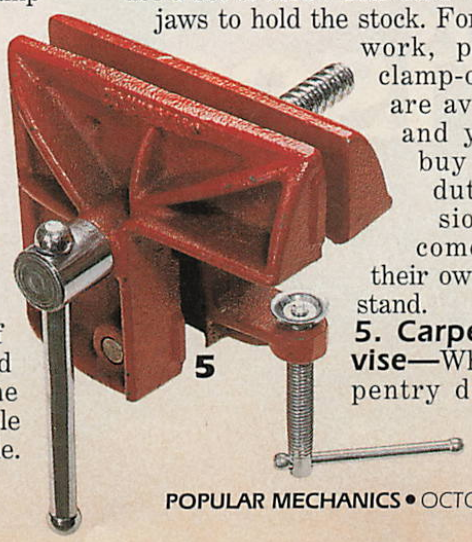
And if perpendicular holes are too limiting, angle vises have jaws that pivot from 0 to 90°. The Sears model 25273 drill-press vise shown costs about $33.

3. Miter vise—Unless the work is held firmly in place, nailing or screwing a mitered corner can throw the joint out of alignment. A miter vise holds two adjacent pieces of a mitered frame precisely at 90° and keeps them in that position for fastening or gluing.

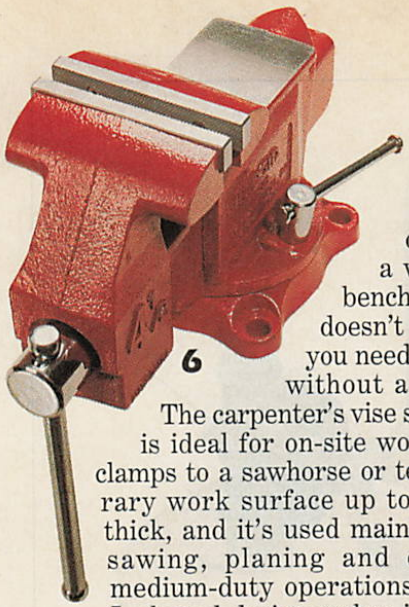
The miter vise shown (about $45) pivots 360° and handles stock up to 4 in. wide. It's designed for permanent mounting to your bench and features knurled locking handles for securing the work. It even has a saw slot for accurately trimming a perfect joint with a single cut. This miter vise is available from Woodcraft, 210 Wood County Industrial Park, P.O. Box 1686, Parkersburgh, WV 26102.

4. Pipe vise—Not all vises have flat, general-purpose jaws. Standard vises are not only ineffective for handling round stock, but may crush or break the work if too much pressure is applied. The model shown is designed specifically for holding round stock such as pipe and utilizes a chain to get the job done. The chain grips the work through a lever-activated cam and holds it tightly against a serrated V-shaped jaw. The Sears model 52147 shown attaches to a bench and comes with accessories for pipe bending. It costs about $110.

Other pipe vises are available that use a set of screw-activated V-shaped jaws to hold the stock. For on-site work, portable clamp-on units are available, and you can buy heavy-duty versions that come with their own tripod stand.



5. Carpenter's vise—While carpentry does not always re-



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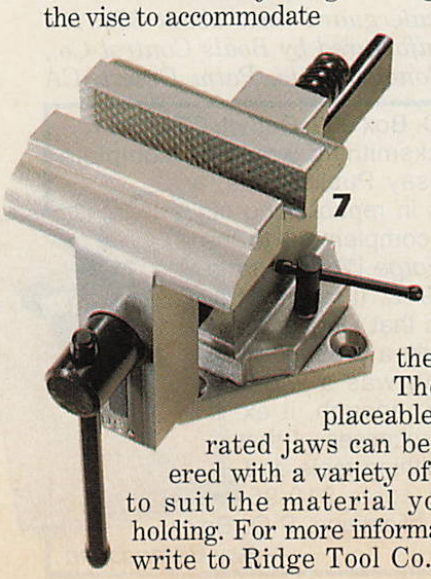
quire a workbench, that doesn't mean you need to do without a vise. The carpenter's vise shown is ideal for on-site work. It clamps to a sawhorse or temporary work surface up to 2 in. thick, and it's used mainly for sawing, planing and other medium-duty operations. The L-shaped design makes it particularly well-suited to working with wood because it holds your work either vertically or horizontally. The cast-iron jaws open up to 3½ in.—enough to hold a 4 × 4. For those who never leave their bench, this type of vise is also available for permanent attachment. The carpenter's vise shown (No. 12L62) costs about $28. Contact Woodcraft, 210 Wood County Industrial Park, P.O. Box 1686, Parkersburgh, WV 26102.

6. Machinist's vise—For mechanics, machinists and metalworkers, there's one style of vise that just about does it all. The Ridgid utility vise shown (No. 4000-R) features 4½-in.-wide jaws that open to 5 in., and it weighs a robust 27 pounds. Other Ridgid versions range from a 3-in.-jaw model to an 8-in.-jaw example that opens to 12 in. and weighs almost 200 pounds.

The model 4000-R costs about $89 and features a built-in anvil directly over the vise base, V-shaped pipe-vise jaws for holding round stock and a swivel base for adjusting the angle of the vise to accommodate



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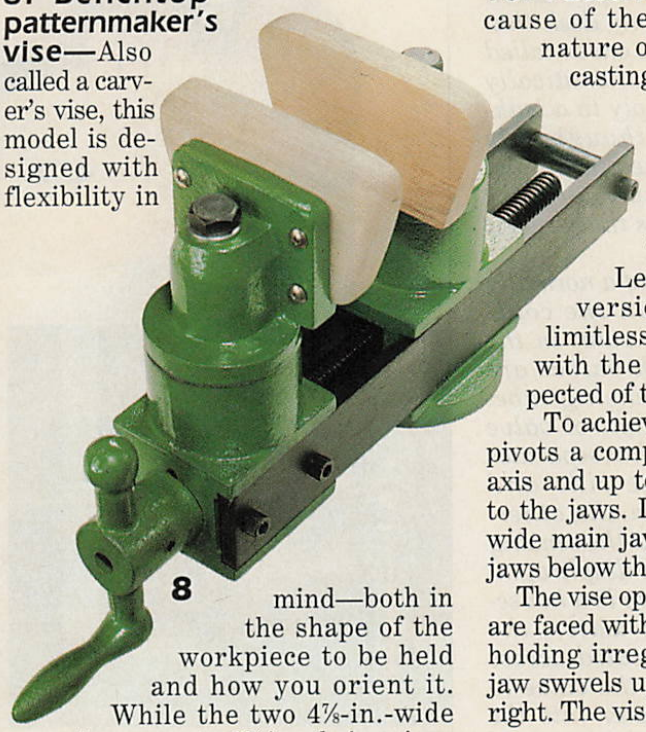
the job. The replaceable serrated jaws can be covered with a variety of caps to suit the material you're holding. For more information, write to Ridge Tool Co., 400 Clark St., Elyria, OH 44036.

7. Utility vise—If a full-size mechanic's vise looks like what you need, but it's just too big and heavy, this downscaled unit might fit the bill. At only 9 pounds, this unit's 3½-in. jaws open to an ample 4 in. And like its big brother above, it has a 360° swivel base for orienting your work at the best angle. Dubbed the Americana Line vise, the model 31335 shown costs about $30. Contact Wilton Corp., 300 South Hicks Rd., Palatine, IL 60067.

8. Benchtop patternmaker's vise—Also called a carver's vise, this model is designed with flexibility in



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mind—both in the shape of the workpiece to be held and how you orient it. While the two 4⅞-in.-wide jaws open to 6⅝ in., their unique quality is that they pivot independently to more effectively hold irregular objects. Plus, the entire vise swivels 360° so you can easily reach each side of the project. It's attached to a workbench with a single threaded rod and is easily removed when not in use.

The model shown (No. 801-802) costs about $95 at Woodworker's Supply, 1108 North Glenn Rd., Casper, WY 82601.

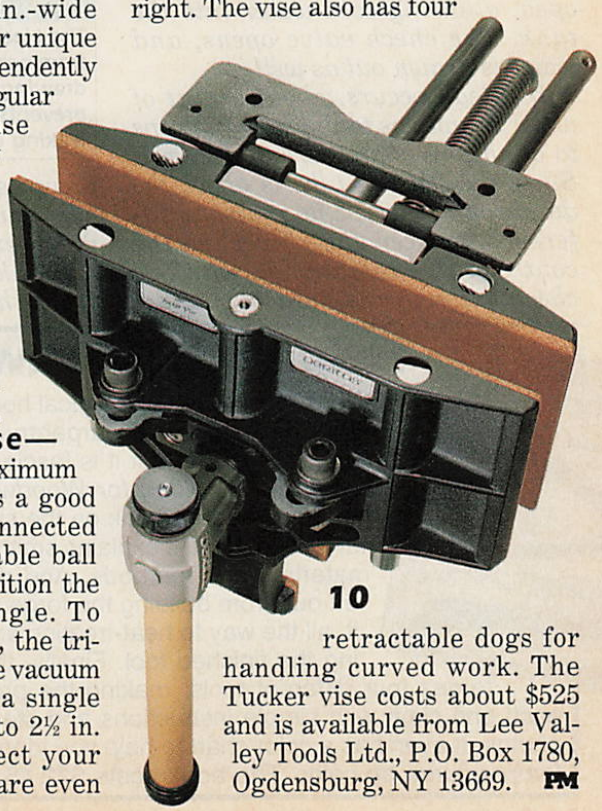
9. Swivel/vacuum vise—For light-duty work and maximum flexibility, this swivel vise is a good choice. The vise head is connected to the base through a lockable ball joint that enables you to position the work at any imaginable angle. To keep the vise firmly in place, the triangular base features a unique vacuum plate that's activated with a single lever. The 3-in. jaws open to 2½ in. and rubber jaw pads protect your work from marring. There are even V grooves for handling round stock. The swivel/vacuum vise costs about $26. To obtain more information, contact the company, General Hardware Mfg. Co., 80 White St., New York, NY 10013.

9

10. Patternmaker's vise—Because of the varied but exacting nature of making patterns for castings, patternmakers used sophisticated vises that combine ultimate flexibility in work orientation with maximum stability. The Tucker vise from Lee Valley is an up-to-date version that boasts nearly limitless jaw positioning along with the standard features expected of traditional vises.

To achieve this, the jaw assembly pivots a complete 360° on the screw axis and up to 90° on an axis parallel to the jaws. In addition to the 13-in.-wide main jaws, the vise has smaller jaws below the screw assembly.

The vise opens to 12 in. and the jaws are faced with cork/rubber liners. For holding irregular shapes, the front jaw swivels up to 10° left and right. The vise also has four



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retractable dogs for handling curved work. The Tucker vise costs about $525 and is available from Lee Valley Tools Ltd., P.O. Box 1780, Ogdensburg, NY 13669. PM

Homeowners Clinic

BY NORMAN BECKER, P.E.,
Contributing Editor
PM Illustrations by
George Retseck

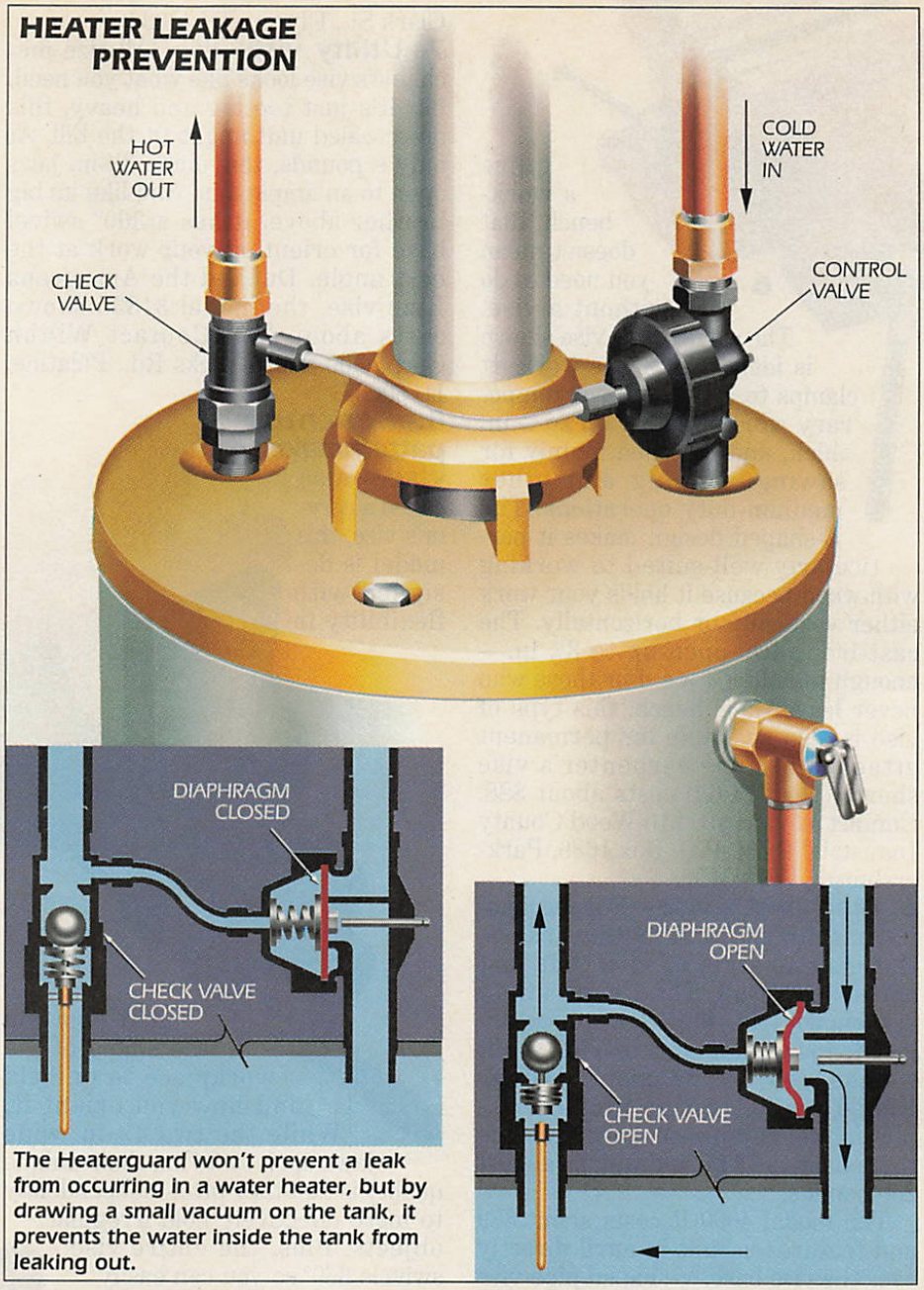
Valve Stops Water Heater Leakage

Every once in a while, information about a device crosses my desk that I feel is noteworthy. This one is called Heaterguard, and it automatically shuts off the water supply to a leaking water heater. Although this device could be quite helpful to any homeowner, it's of even greater value in vacation homes that are left vacant for long periods.

Heaterguard consists of a normally closed control valve in the cold-water line and a check valve in the hot-water outlet. Both valves are interconnected by a sensing tube. The normally closed control valve contains a diaphragm that separates tank pressure on one side and household pressure on the other. Note in the drawing that the sensing tube is located above the diaphragm. Consequently, when there is a household demand for hot water, the pressure differential created across the diaphragm causes the valve to open, allowing cold water into the tank. The check valve opens, and water is drawn out as well.

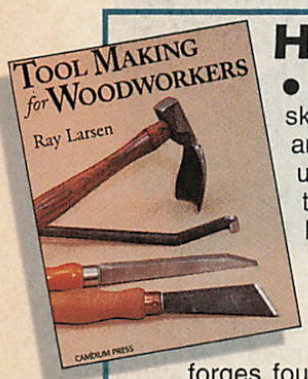
If a leak occurs, about a pint of water escapes as tank pressure drops to atmospheric pressure at 14.7 psi. Since the sensing tube is above the diaphragm, there is no pressure difference between the valves, so the control valve remains closed. The check valve in the hot-water outlet prevents introduction of air from an open faucet, and the resulting vacuum prevents further leakage from the tank. Little or no water flowing from the hot-water tap is a sign to the homeowner that there is a problem with the heater.

Heaterguard costs about $50. It's manufactured by Boals Control Co., 11 Conejo Circle, Palm Desert, CA



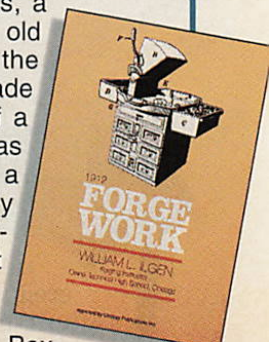
The Heaterguard won't prevent a leak from occurring in a water heater, but by drawing a small vacuum on the tank, it prevents the water inside the tank from leaking out.

Help With Metalwork



● Blacksmithing is not a typical homeowner skill in the sense that carpentry, painting and plumbing are, but it is fascinating and useful. *Tool Making for Woodworkers* is the finest modern book on the subject we have seen. First, it explains smithing tools, materials and methods. And nothing is left out, from building the forge and firing it, all the way to heat-treating and polishing the finished tool. Finally, the author forges four different tools, making the process for each one clear with simple instructions and step-by-step photos. It even has a color chart to help you identify metal temperatures by color. The book costs $22.45 postpaid from Cambium Press, P.O. Box 909, Bethel, CT 06801.

No discussion of blacksmithing would be complete without referring to Lindsay Publications, a company that specializes in republishing old technical books. A nice complement to the aforementioned book is *Forge Work*, a trade school text written in 1912. It's one of a dozen books on the topic that Lindsay has available. The book is truly a product of a time when blacksmithing was a widely practiced trade. Naturally enough, it explains the steel-making processes of that era and how to make smithing tools and ornamental ironwork. It costs $10.95 postpaid from Lindsay Publications, P.O. Box 538, Bradley, IL 60915.



—Roy Berendsohn

PM PHOTOS BY ROSARIO CAPOTOSTO

92260. To find a distributor, contact the manufacturer.

Lifting Resilient Tiles

The floor tiles in my 11-year-old home seem to be lifting. When we step on them, they make a crunching sound as if there were sand under them. What causes this?

BOB QUICK
SEBASTIAN, FL

I assume that you are referring to tiles on a concrete slab. If this is indeed the case, moisture is collecting beneath the tiles and causing them to lift. The crunching sound is probably efflorescence under the tiles. Efflorescence is caused by soluble salts in the concrete slab that dissolve in the water as it migrates through the slab. When the water evaporates, the salts remain encrusted under the tiles. This condition can occur even though you do not see standing water on the floor. To prevent the problem, you will have to reduce or eliminate water below the slab with a drainage system around the perimeter of the foundation. However, installing such a draining system is both expensive and disruptive to the house's landscaping. You would have to decide whether it would be better to install drainage, use another type of flooring, such as carpeting, or simply replace lifting floor tiles periodically.

Not Enough Hot Water

Our 10-year-old boiler was set up by the house's previous owner so that domestic hot water is preheated first in an electric water heater. We've noticed that the water starts out very hot, then cools off rapidly until it is uncomfortable. Two people cannot take a shower one after the other. This seems to be an inefficient arrangement. Is there a way to improve it?

CAROL ZAMBA
CONYNGHAM, PA

When the hot water is generated through the heating system, the boiler operates in the summer and winter. The previous owner probably used the electric water heater by itself in the summer to produce hot water. In the winter, he may have continued to use the water heater as a preheater, but with the power shut off. Preheating the water in a storage tank so that the water approaches the basement air temperature is considered energy-efficient. However, preheating the water electrically is not efficient, and it is usually not necessary.

Fluctuation in water temperature and a shortage of hot water is a problem associated with older boilers that produce the hot water in a coil inside the boiler. In these cases, water enters the coil and leaves with its temperature raised by 90° to 100° F. The system is designed with a specific water-flow rate through the coil, and if water flows through the coil at a faster rate, less heat is transferred to it. Consequently, many boilers have a flow-regulating valve that restricts water flow.

Normally, when hot water is generated in a coil, the problem is not enough hot water for simultaneous demands. It shouldn't be a problem when the demand is sequential, such as one shower after another. Your problem may be caused by cold water flowing through the coil too rapidly to absorb the heat. It is also possible that lime deposits have built up in the coil. The deposits act as insulators and reduce heat transfer.

Consult a plumbing and heating contractor about the best way to solve the problem. Increased efficiency in water heating is not only more comfortable but often pays for itself in reduced utility bills. PM

BUZZWORD . . .

Drainable Siding

● Exterior insulated finish systems consist of synthetic stucco applied over insulation board, which is then installed over sheathing. These systems have been used commercially for years, but they received some bad press recently when homeowners complained that these systems were failing. Moisture penetrated the wall and the sheathing and structural members rotted. While manufacturers, contractors and homeowners swap complaints, drainable siding is entering the picture. Manufacturers say that this system allows moisture that gets behind the stucco to drain harmlessly to the outside.

—Roy Berendsohn

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

Just ask Norman about it. Send your question to Homeowners Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.

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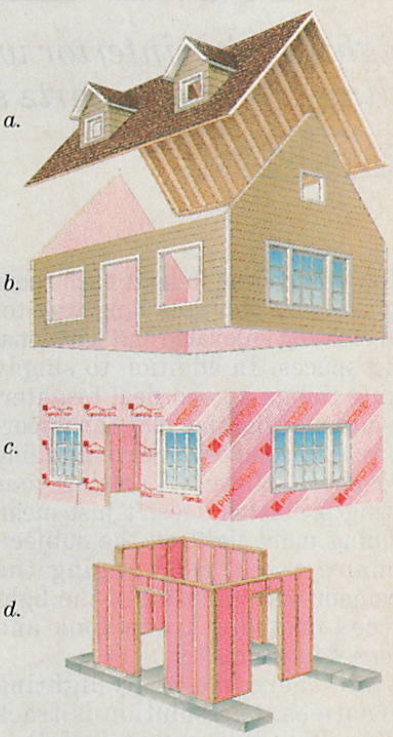

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HOME IMPROVEMENT

Installing Track Lighting

Brighten your interior with this flexible, ceiling-mounted quartz system.

BY NEAL BARRETT

● How you choose to light each room of your house can go a long way toward creating enjoyable and functional living spaces. In addition to simply making things a good deal brighter, well-designed lighting plays an important role in composing a comfortable atmosphere. However, solving your lighting problems doesn't just mean shedding more light on the subject. In many cases, rearranging the placement and intensity of the light sources provides a new look and increases functionality.

While there are many lighting alternatives, one solution is track lighting. With this system, individual lamps, or lighting heads, fit into tracks secured to your ceiling. Because you install the tracks to suit your space, you end up with a custom configuration that's tailored to your needs. And once in place, the lamps can be repositioned along the tracks to vary the lighting effect or to accommodate new requirements. Best of all, because the power comes from an existing ceiling junction box, track lighting can usually be installed without any remodeling.

The choices in lighting heads for track lighting range from small, unobtrusive can-shaped fixtures to large, high-tech lamps that lend drama to an interior space. For our installation, we selected a system made by Juno Lighting Inc. (2001 South Mount Prospect Rd., P.O. Box 5065, Des Plaines, IL 60017) that features low-profile heads that use quartz bulbs. These lamps offer a quality of light that is similar to low-voltage halogen fixtures, but at a lower cost. The system also does not require the transformers that are part of low-voltage lighting.

The lighting that we installed consists of Juno One-Circuit Trac-Master track sections and connectors, and T421 lamp fixtures. These fixtures use 55-watt, PAR16 bulbs. The track is available in 2-, 4-, 6-, 8- and 12-ft. lengths to provide great flexibility in configuring your installation.

Installing the tracks

First, study the layout of your room and decide on the best placement of the track sections. Plan for the first section to start at an existing ceiling junction box from which the new lighting will receive power. From there on, you can carry the track along one side of the room, or around the entire perimeter. T and L track connectors provide flexible layout and track branching.

When planning the track locations, keep in mind that the lamp fixtures can be adjusted in any direction so you have the ability to provide both general room illumination and task lighting from a single track. After you've determined the best track configuration, preassemble all necessary track, connectors and lighting fixtures before beginning the installation.

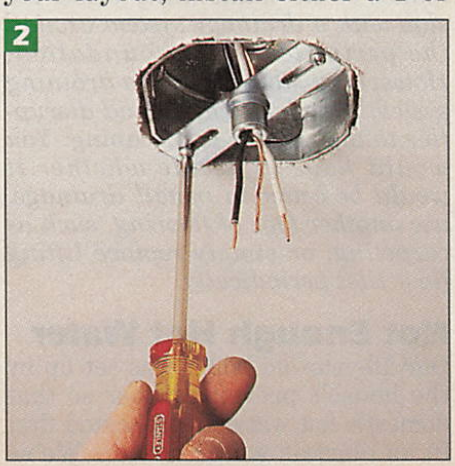
Start the job by shutting off the circuit breaker or removing the fuse that controls the power to the ceiling fixture. Double check that the power is off before starting the new wiring.

Remove the globe or diffuser and bulb from the existing ceiling fixture. Then, loosen the screws that hold the fixture in place and pull it down to expose the wire connections. Unscrew the wire connectors (Photo 1) and remove the fixture.

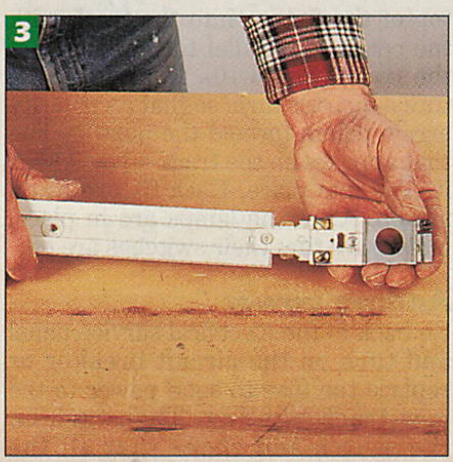
With the old lamp out of the way, replace its mounting strap with the new strap that's supplied with the track feed connector (Photo 2). Thread the hollow stud into the center of the strap and feed the circuit wires through the stud.

Slide the feed connector onto one end of the first track section (Photo 3), and use the setscrew to lock the connector in place. Depending upon your layout, install either a T or

Turn off power to circuit and remove existing fixture's mounting screws. Unscrew wire connectors to disconnect wires.

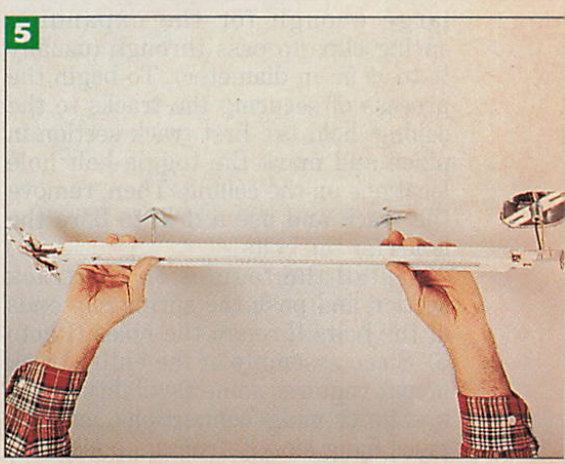


Remove the old mounting strap and replace it with the track-light strap. Feed wires through center stud.

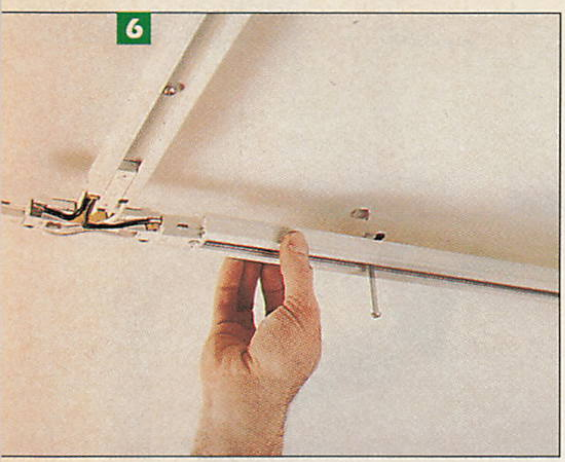


Slide feed connector to the first length of track and secure with a setscrew. Connector slips over center stud.

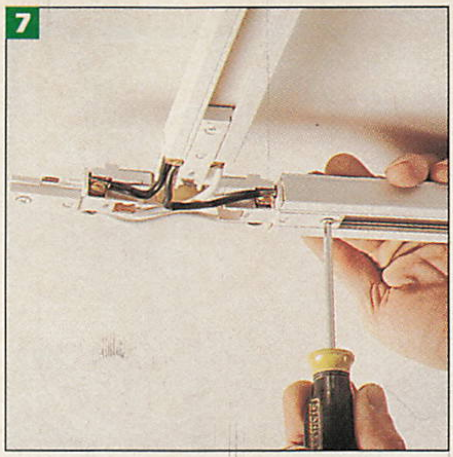
Use connectors to join tracks. Adjustable connector (shown) also handles straight runs. T connectors join three tracks.



After boring toggle bolt holes, install bolts in track and hang unit from ceiling. Install all tracks before tightening.



Join second track to first by sliding it onto connector. Then, push the toggle bolts through ceiling holes.



With all tracks hanging loosely, secure connectors with setscrews. Then, tighten bolts to draw tracks to ceiling.

After securing feed connector to fixture strap, fasten circuit wires to track-lighting terminals on connector.

Install the feed-connector cover and secure it with a screw. Then, install the rest of the connector covers the same way.

Insert lamp with contacts parallel to track. Then, rotate ¼ turn to align polarity arrow with polarity line on track.

Turn on circuit and adjust lamps for desired lighting. Lamps can be rotated, angled and positioned along tracks.

adjustable L connector to the other end of the track (Photo 4). Use the T connector when you need to join three track sections. The L connector is adjustable to handle straight and angled joints between two tracks.

Each length of track is held to the ceiling with toggle-bolt-type hollow-wall fasteners. The toggle bolts require holes in the ceiling that are large enough for the expanding spring clips to pass through (usually ½ to ⅝ in. in diameter). To begin the process of securing the tracks to the ceiling, hold the first track section in place and mark the toggle-bolt hole locations on the ceiling. Then, remove the track and use a drill to bore the holes for the bolts.

Install the toggles on the track section and push the spring-clip ends of the bolts through the holes (Photo 5). Since assembly of the entire track layout requires some flexibility in the system to make connections, let each piece hang loosely from its bolts until all the tracks are in place.

Mark and bore the holes for the second length of track. Slide this second section onto the connector at the end of the first piece, then feed the toggles through their holes in the ceiling (Photo 6). Tighten the setscrew that holds the track to the connector (Photo 7).

Proceed in this way, adding one section at a time, until all the tracks have been secured to the ceiling. Complete the track assembly by installing dead-end fittings on the open ends of the final sections.

Tighten the toggle bolts, working gradually around the entire track assembly. Don't tighten the first bolts completely, or it will be difficult to tighten the rest. As the track approaches the ceiling, make sure that the feed connector slips over the threaded stud on the fixture strap. Fasten the nut to the fixture-strap stud to lock the connector in place.

Wiring and lamps

With all the tracks and connectors assembled and secured to the ceiling, it's time to attach the electrical wires that supply power to the system. Connect each circuit wire to the appropriate screw terminal on the feed connector (Photo 8). Be sure to attach the black power lead to the brass screw and the white neutral lead to the silver screw. Then, attach the bare ground wire to the black or green screw. Affix the feed-connector cover (Photo 9) and install the rest of the connector covers.

To install the first lamp, push the top of the fixture into the track with the contacts parallel to the length of the track (Photo 10). Rotate the fixture a quarter turn, so that its polarity arrow points toward the polarity line that appears on the track—you'll hear it click into place. Each fixture has a switch. After the lamps are in place, make sure that their switches are on.

Adding power

Go back to the electrical service panel and turn on the circuit breaker or replace the fuse to send power to the new track lighting. Then turn on the switch and check that all the lamps work. Adjust the fixtures to provide illumination exactly where it is needed (Photo 11). PM

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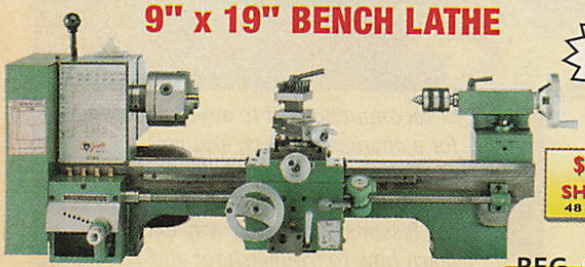

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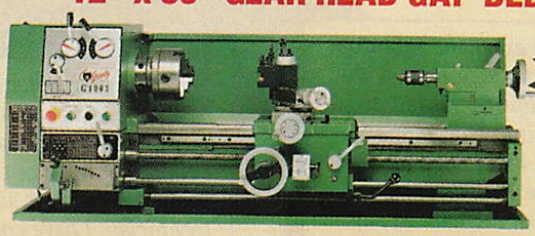

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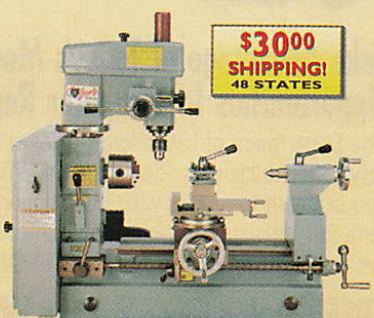

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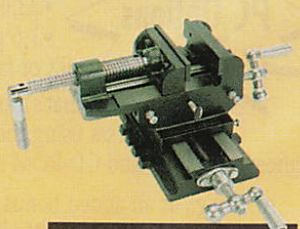
- Drill chuck ⅝"
- Spindle MT #2
- Swing 14"
- Drilling capacity ¾" steel
- Table diameter 12¾" cast iron
- Table swing 360°
- Approx. ship. weight 155 lbs.

G4008

$189.95

CROSS-SLIDE VISE

This vise features an exclusive slide bar under the vise jaw to prevent jaws from tilting up or sideways when tightening.



- Large 4" capacity
- Overall height 5¼"
- Base measures 5" x 10½"
- Jaw width 4"
- Jaw opening 3½"
- Bottom slide travel 4"
- Top slide travel 4"
- Approx. weight 25 lbs.

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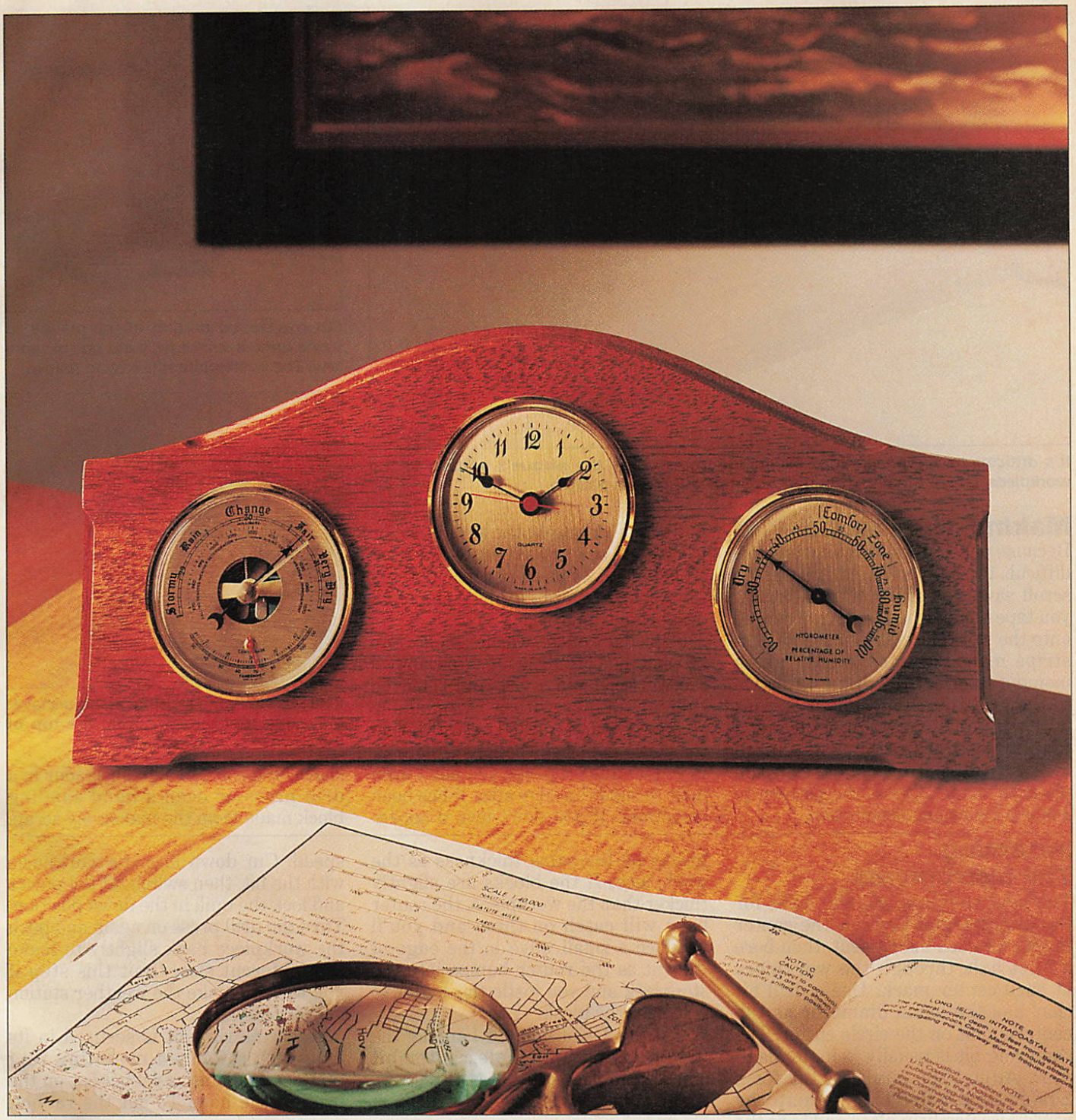


SHOP PROJECT

Weather Report

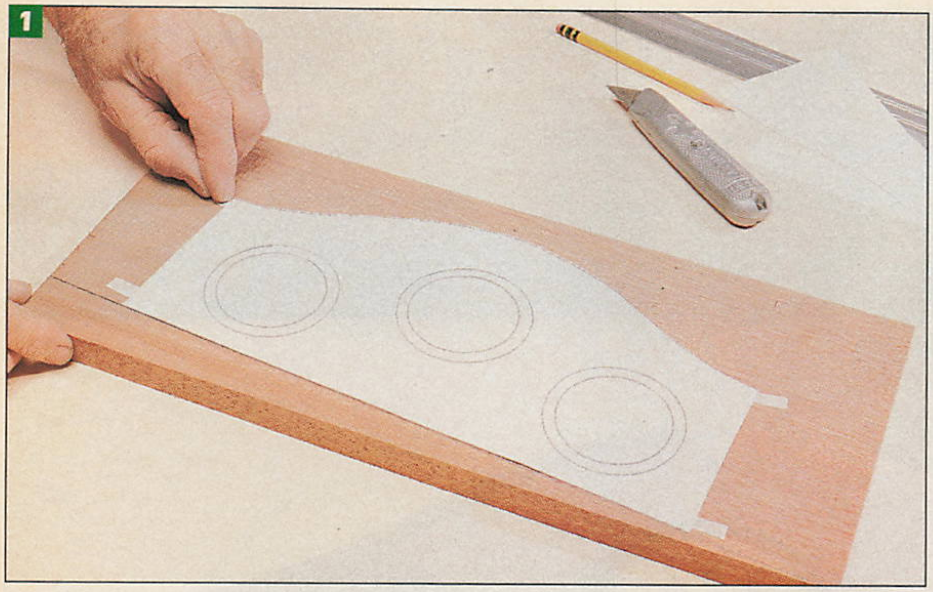
A desktop weather station to improve your predictions.

BY ROSARIO CAPOTOSTO, Contributing Editor

● You can keep abreast of weather conditions and the time of day with this attractive desktop weather station. Its mahogany plaque and brass-rimmed instruments are eye-catching, and its compact size allows you to display it just about anywhere. It can even be made to hang on a wall. It consists of a combination barometer/thermometer, a hygrometer and a clock. The barometer/thermometer is useful for predicting local weather trends because it tells you at a glance whether atmospheric pressure is rising or falling. The hygrometer measures the relative humidity, which is the moisture in the air as a percent of what the air is capable of holding at that temperature. And the clock is there to remind you how far behind you are falling!

The project is ideal if you don't have time for elaborate woodworking and you just want to knock off something in a few hours. It requires few tools, and the plaque is so small that you can make it from a piece of scrap. We used a ⅞-in.-thick piece of mahogany. But this thickness is only necessary if you plan to hang the weather station on the wall, as the barometer/thermometer is ⅞-in. thick. For a desk set, a ¾-in.-thick piece will work just fine.

PM PHOTO BY J.R. ROST



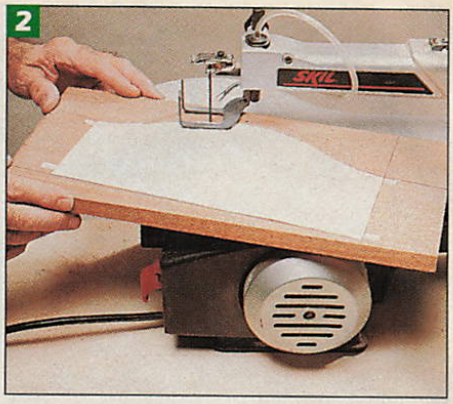
It's difficult to see pencil lines on mahogany, so tape the plaque's pattern to the workpiece. Orient the pattern to produce a pleasing grain pattern.

Making The Plaque

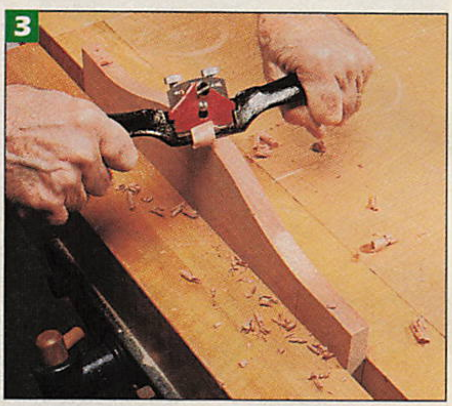
Because pencil lines on mahogany are difficult to see, you'll find it easier to scroll saw the curved cutting lines if you tape a paper pattern of the plaque onto the workpiece. If you use ribbon-stripe mahogany as we did, take a moment to orient the pattern relative to the grain direction (Photo 1). This will prevent you from making a plaque with grain that runs in an awkward direction relative to the plaque's shape. Adjust the pattern to achieve a pleasing orientation.

Cut the plaque on the scroll saw, or use a band saw or sabre saw. We used a blade with 10 teeth per inch and fed the workpiece into the blade at a moderate rate (Photo 2).

The edges of the workpiece have to be smoothed after sawing. We clamped the workpiece in a vise and removed the saw marks with a razor-sharp spokeshave and worked outward from the curve in both directions (Photo 3). If you do this properly, you don't even have to sand the edge after it has been smoothed. If you don't own a spokeshave, you can use a drum sander in a drill press or even a hand sanding block made from the mahogany scrap.



Cut the curved portion of the plaque to shape using a scroll saw, band saw or sabre saw. The white pattern is easy to follow.



Remove saw marks using a spokeshave. Move the tool outward from the top of the curve in both directions.

Mounting The Instruments

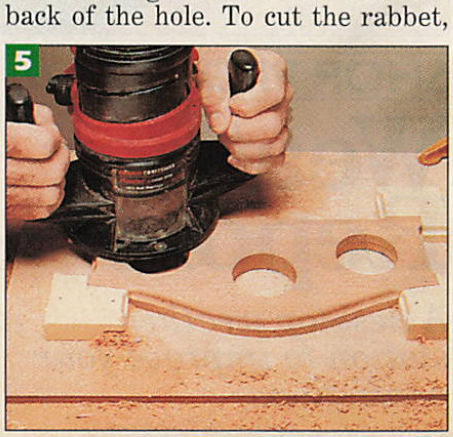
The next step is to cut the holes for the instruments. Lay out the center marks for each instrument, then bore a pilot hole through the workpiece at each center mark. Use a drill bit that has the same diameter as the centering bit on the circle cutter. The centering bit is usually $\frac{3}{8}$ in. in diameter. Adjust the circle cutter for a $2\frac{5}{16}$-in.-dia. hole. Then, clamp the workpiece firmly in place and bore the hole, making a partial cut from both sides (Photo 4). Although mahogany is not a particularly hard wood, don't run the drill press higher than 600 rpm, or medium speed, in order to avoid burning the wood.

Next, use a router to make the stopped molded cuts on the plaque edges (Photo 5). To achieve these cuts, tack nail four corner blocks to a plywood panel. Each block should stop the travel of the router when the router bit's pilot bearing strikes it. The blocks also prevent the router from tipping as you near the end of the cut. It's important that the blocks be the same thickness as the workpiece. If the blocks are slightly thicker than the workpiece, the router base will catch on them and you'll produce a small wave in the edge of the cut as the router bumps into the stopblock and you jostle the router to ride over the block.

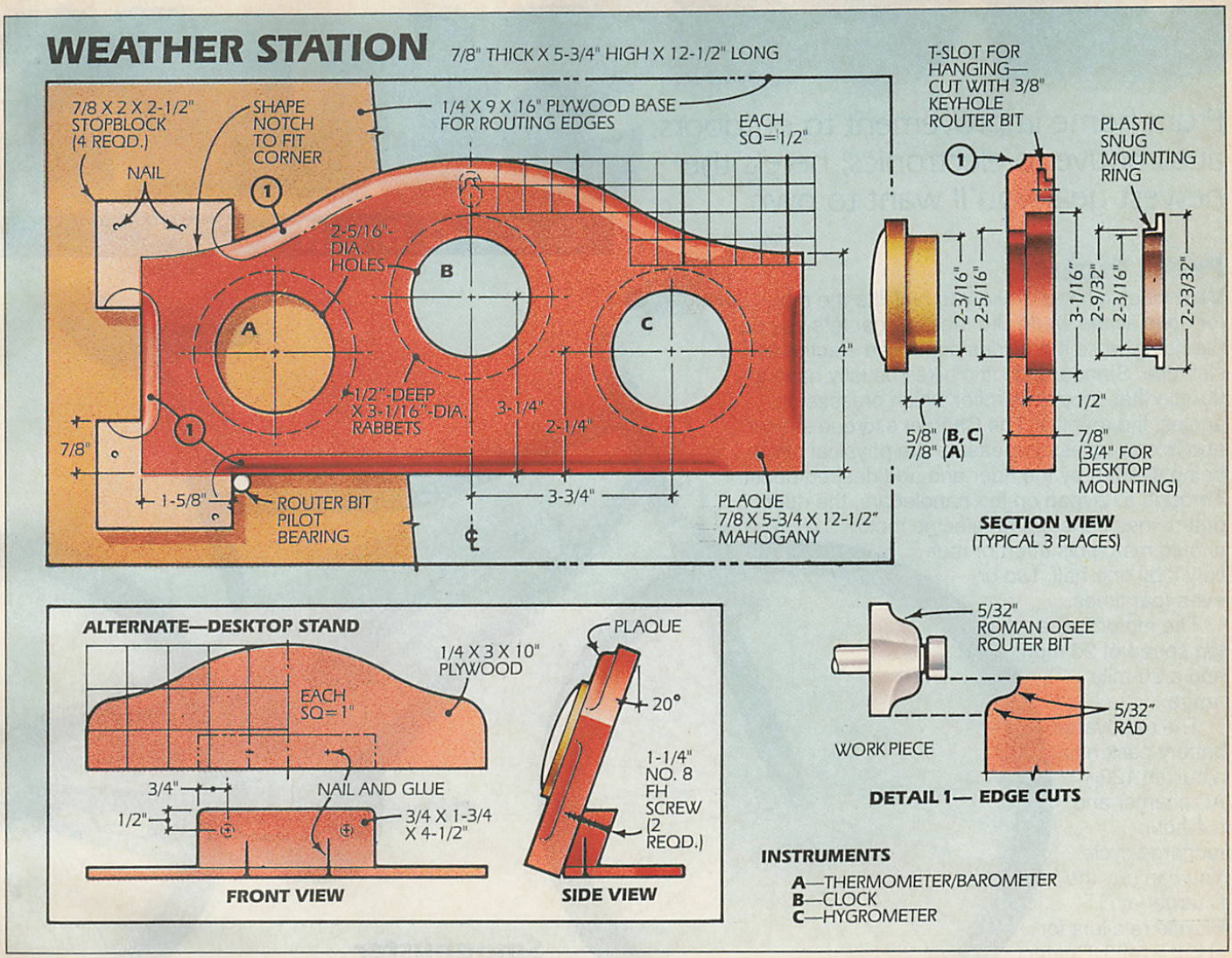
Cut the T-slot hole for hanging the plaque using a keyhole router bit chucked in the drill press (Photo 6). Again, run the drill press at medium speed. Cut down into the workpiece with the bit, then switch off the power and lock the quill in the down position. Turn the drill press on again and push the workpiece back slightly to make the undercut slot. Omit this step if you want to make the weather station a desk accessory.

Each instrument is secured in its hole with a flanged mounting ring that bears against a rabbet cut on the back of the hole. To cut the rabbet,

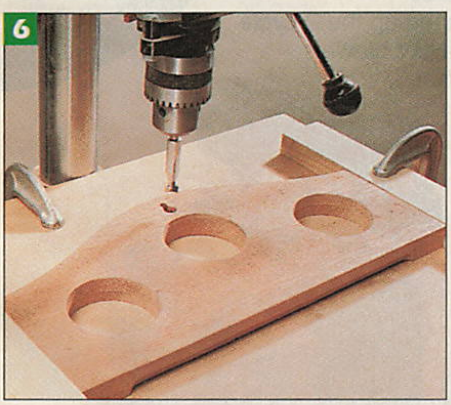
Clamp the workpiece firmly while using a circle cutter to make the holes. Cut from both sides toward the center.



Cut the stopped molding on the plaque with a router. The blocks hold the workpiece and stop the router bit travel.



PM ILLUSTRATION BY EUGENE THOMPSON



To cut the T-shaped slot, lower the bit into the workpiece, and lock the drill-press quill. Next, move the workpiece backward.

Hold the workpiece firmly in place, and cut a rabbet around the mounting hole's circumference using a router and rabbet bit.

Before finishing the weather station, test fit the three instruments and their mounting rings.

PM PHOTOS BY ROSARIO CAPOTOSTO

use a ⅜-in.-dia. router bit set to make a ½-in.-deep cut (Photo 7).

Before sanding and finishing, test the instruments and rings for fit (Photo 8). The barometer/thermometer (Part No. 46K50.12, $13.95), the clock (Part No. 46K50.22, $19.95) and the hygrometer (Part No. 46K50.02, $6.95) can be ordered from Lee Valley Tools Ltd., P.O. Box 1780, Ogdensburg, NY 13669; 800-871-8158. Include $6 for shipping with the order.

To make the desktop stand, cut the pieces as shown in the plan. Bore and countersink the two holes for the No. 8 screws in the upright, then attach it to the base with glue and nails. Next, use a small C-clamp to hold the stand in position on the back of the plaque. Then, press a screw through each hole to mark the position of the pilot holes in the back of the plaque. Bore ½-in.-deep pilot holes using a 7/64-in.-dia. bit. Attach the stand to the plaque and proceed with finishing.

Sand the plaque with progressively finer sandpaper, from 120-grit to 220-grit. Remove sanding dust with a tack cloth and apply three coats of polyurethane on the front and back of the project. Allow each coat of finish to harden thoroughly before sanding it with 220-grit paper and applying the next coat. Install the instruments, and you're ready to predict the weather. **PM**

Great Stuff

OCTOBER

From home improvement to outdoors, automotive to electronics, here's the newest gear you'll want to own.

Pedal Pusher

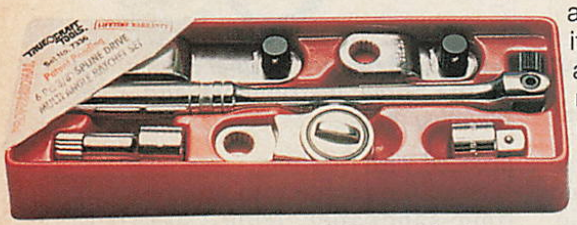
Most electric bikes make you feel like the motor does all the work. But the Charger lets you do the riding while it provides controlled electric assistance. Standard electric bikes usually have a throttle that controls a roller which presses up against the rear tire. The Charger's torque sensor and microprocessor measure the physical effort being exerted by the rider and add desired boost. Through a keypad on the handlebars, the rider determines if the 0.5-hp electric motor should match his effort or multiply it by one-half, two or even four times.

The motor has a top speed of 20 mph and a 20-mile range.

The removable battery pack has a built-in 120v AC charger and a 4-hour recharge cycle. You can buy the Charger at GT Bicycle retailers for about $1495. Contact GT Bicycles, 22 E. Huntington Dr., Monrovia, CA 91016; 818/357-9983; fax: 818/359-9628.

Battle Of The Bolts

Some fasteners are real knucklebusters. They seem to be placed as far out of reach as possible just to challenge your wrenching skills. Now, a ⅜-in. spline-drive multiangle ratchet from Truecraft Tools gives you the edge in the fastener wars. The ratchet squeezes into tight spaces with its multitude of configurations and angles, and its handle allows 180° rotational positions. The set retails for $190 and includes a ⅜-in.-drive reversible ratchet head, 8½-in. flex handle, 2¼-in. offset joint, 2-in. extension and a spline-drive adapter that allows for easy conversion to hex-drive fasteners. The set is available through auto parts stores and from Truecraft Tools, 615 Pierce St., Somerset, NJ 08875; 800-532-8665.



Smogbuster

Husqvarna cleaned up the 2-cycle engine on its 225HBV blower-vacuum, eliminating the cloud of blue exhaust often associated with 2-cycle products. It installed sweeper plates on the crankshaft counterweights and added a catalytic muffler. The sweeper plates reduce crankcase volume and thus raise the engine's compression ratio. This allows the engine to operate with faster and less turbulent fuel-air transfer. This in turn leads to more power, cleaner combustion and less unburned fuel in the exhaust. The catalytic muffler cleans up anything missed in the combustion cycle. The 11-pound device produces a 128-mph airstream at 75 dBA (reasonably quiet). In vacuum mode, it shreds leaves to one-sixteenth-original-size bits. It costs about $230 at Husqvarna dealers. Contact the company at 9006-J Perimeter Woods Dr., Charlotte, NC 28216.

Play 'N' Surf

Access your e-mail while playing a game on your TV via the Internet. It's just one of the neat features of the Sega Saturn Net Link. Now you can surf the Net with a $140 game platform and combine content accessed from a CD drive with online access simultaneously. Game with friends around the corner or around the world. If you don't already have an Internet service provider, you get a month of free service from Concentric Network Corp., and you pay $7.95 to $19.95 per month after that. You'll find the Net Link at toy and consumer electronics stores. Contact Sega of America Inc., 255 Shoreline Dr., Redwood City, CA 94065; 800-733-7288.

Musclecar Wheels

Wheels make the car, especially when it's a machine from the muscle era. Finding the correct wheels for your '60s-'70s performance car is now easier. Coker Tire's new line of reproduction vintage wheels includes the chrome Magnum 500 used on many 1968-73 Fords and Chryslers, the Buick Rallye, the SS-396 featured on the 1969-70 Chevrolet Chevelle SS, and the Oldsmobile SS for 1968-74 Olds 442 and Cutlass models. Wheels are also available for Corvettes, Camaros and other makes, directly from Coker. A variety of wheel backspacing and a selection of tire/wheel combinations are also offered. Prices range from $92.50 to $175. Contact Coker Tire, 1317 Chestnut St., Chattanooga, TN 37402; 800-251-6336.

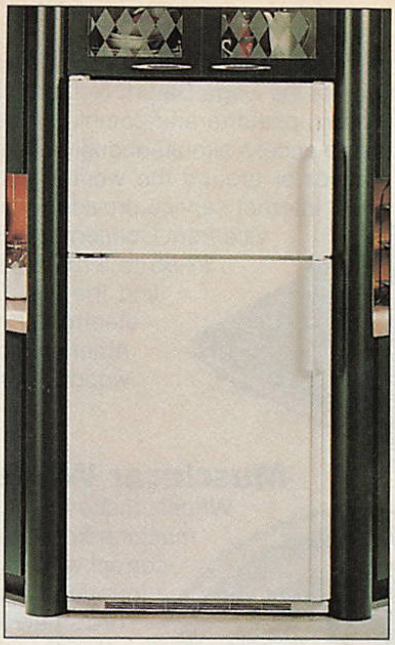
Club Car

After four years of European success, the Hill Billy electric golf trolley has made it to the United States. Powered by a removable battery that comes with a charging unit, the Hill Billy combines the best of golf carts and hand trolleys. And at just 16.7 pounds, it's easy to fold up and put in the trunk after your round. Available through direct mail only, the 2-wheel unit costs $395 (including battery and charger) and the 3-wheeler is $44 more. Contact Hill Billy, 9 E. Pueblo St., Santa Barbara, CA 93105; 888-682-7757; fax: 805/682-7537.

Split Decision

It used to be that a portable log splitter was you grabbing the maul and walking over to the woodpile. The Craftsman Quick Split is powered by a 4-cycle, 3.8-hp engine. The machine separates into two parts: the engine and hydraulic assembly (45 pounds) and the ram (85 pounds). You attach the two with snap-fit hydraulic lines. It costs about $900 at Sears stores. Contact Sears, Dept. 703, 333 Beverly Rd., BC118B, Hoffman Estates, IL 60179.

Easy To Live With



If you've taken an oath that your next refrigerator is going to be more quiet, keep food fresher and just be easier to live with than your present model, put the Maytag Dual Cool appliance on your list. It has separate temperature controls for the refrigerator and freezer compartments, automatic moisture control to eliminate condensation on the cabinet, a commercial-grade condenser that never needs cleaning, and increased thermal insulation that reduces noise and improves its energy efficiency. The company says the machines are 50% quieter than its previous models. Another nice touch is the Safekeeper compartment option on some of the top-mount appliances. This is a tamper-resistant compartment for holding items, such as medicines, that need to be refrigerated. The 24-cu.-ft. model shown costs about $980 at Maytag dealers. Contact the company at 403 W. Fourth St. North, Newton, IA 50208.

Dinner's Ready

The Warm & Serve Zone is a low-wattage smooth-top element that keeps foods warm, allowing you to keep cooking on the other four elements or carry on with other activities—like eating. It's a feature on Frigidaire's smooth-top free-standing Gallery ranges. The Zone is located between the two rear elements, and it accommodates pots up to 9 in. in diameter. Its maximum temperature setting is 170° F. For large-capacity warming, three of the four appliances in the new line have a warming drawer below the oven. The four models in the line range from $949 to $1679. The model shown costs $1250, and it has a convection oven. The appliances are sold at Frigidaire dealers. For more information, contact the company at 6000 Perimeter Dr., Dublin, OH 43017, or call 800-374-4432.

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Get Organized

If you have to wade through an avalanche of cups, cassette tapes, notes and the like every time you climb into your full-size pickup cab, check out the Wolf Deluxe Contractor Console. You'll find special compartments for any size beverage; a center tray for your cellular phone; a large upper compartment that holds odds and ends such as CDs, sticky notes and cassette tapes; a padded lid that will hold a notepad; and a storage area with a built-in beverage cooler and a removable plastic tray. Designed for a factory look, the console is easily removed when extra seating is needed. The console sells for $139.95 at auto parts stores and from Wolf Automotive, 201 N. Sullivan St., Santa Ana, CA 92703; 800-444-WOLF.

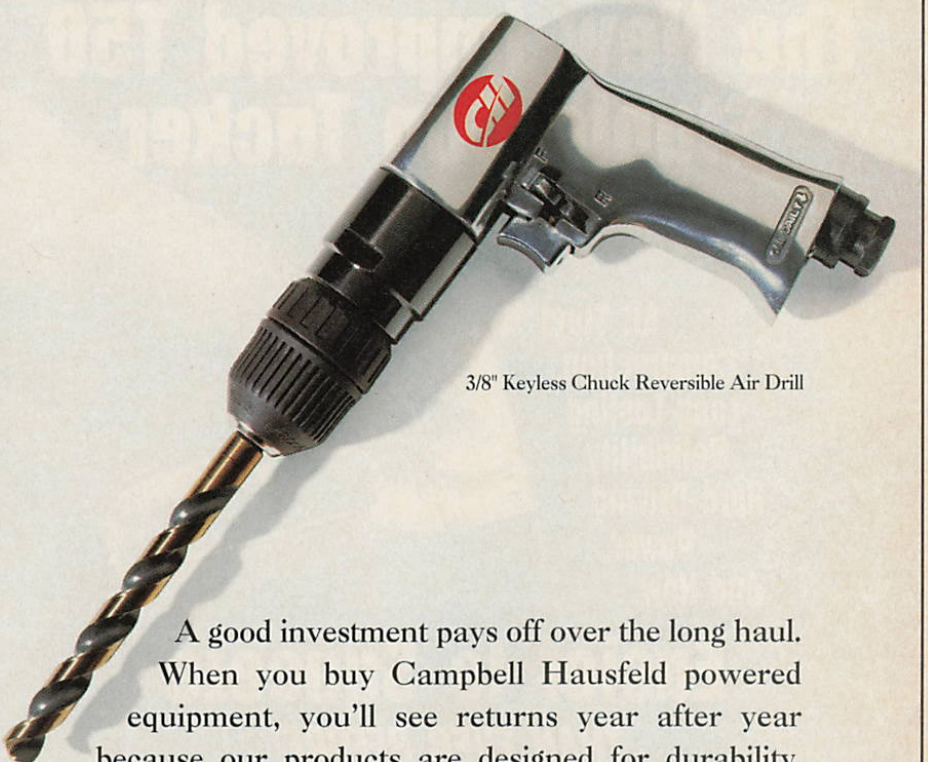
Switch Blade

It's not unusual to have the nicest lawn at the beginning and end of the season because of mild weather conditions. This Scotts mulching mower has a reversible blade that helps you round off your grass-cutting season or prepare for next year. When one side is dull, just turn it around. It has other commendable features as well: a 6-hp primer engine operated with a control on the handlebar console; single-lever height adjustment; toolfree conversion between mulching, bagging and side discharge; and a rolled-edge deck with a deep profile. The mower costs about $300 at Home Depot. Contact Scotts Power Equipment, 219 Franklin Rd., Brentwood, TN 37027; 800-646-8442.

This is a toy.

This is an investment.

(No matter what your wife says.)



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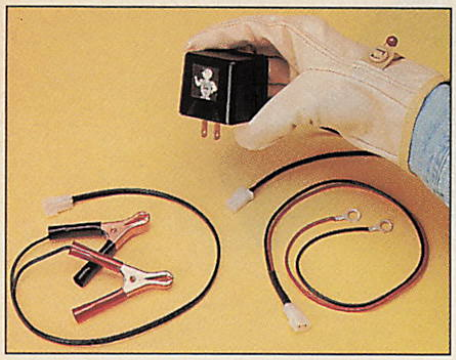
Current Affair

Keep your batteries from getting lazy. The Mini Universal battery charger for small- to medium-size 12-volt lead-acid batteries has a 1-amp charging rate with tapered output. Charging times range from 2 to 12 hours. The unit can also be used as a battery warmer in automobiles and trucks, keeping batteries at full charge on cold nights. Included are two output cable assemblies, one with clip-on connectors and the second with ring locks for permanent connection to the battery. The charger costs $17.95 plus shipping and handling from James Electronics Inc., 4050 N. Rockwell St., Chicago, IL 60618; 773/463-6500.



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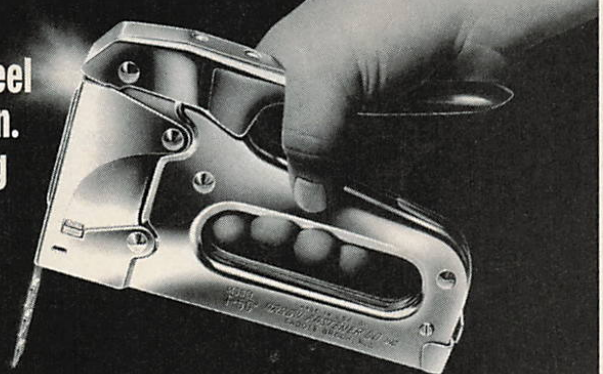

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Knock Off

Low-grade fuel, warmer than normal weather or irregularities in your fuel mixture are just a few of the simple ways your boat's engine can get thrown out of tune. Livorsi Marine's engine-knock meter can help you detect any maladjustments and prevent possible engine damage. Using an acoustic sensor, the system transmits engine sounds to a vibration- and moisture-resistant electronic control unit that analyzes the input and detects engine knock, detonation and drivetrain disorders. The Gaffrig gauge provides constant feedback, and an optional light and alarm will signal severe problems. The fuel you save just by running with a properly tuned engine could offset the $540 price tag. For more information, contact Livorsi Marine, 888 E. Belvedere Rd., Suite 117, Graylake, IL 60030; 847/548-5900.

Wind Tunnel

This vacuum cleaner uses air-directing channels molded into its agitator housing to improve its cleaning capability. The channels direct airflow from the agitator into the bag, and in doing so, capture the dirt particles rather than scatter them as the machine moves forward. All the vacuums in the 4-model Wind Tunnel line have 12-amp motors and multistage air filtration. The top-of-the-line model shown (about $400) filters incoming air in six stages. It has a 15-in. cleaning width, a bag-change indicator light and another light that indicates when the airstream is clean enough to move on to another section of floor. The other three machines cost $290, $330 and $380, and all are sold at department stores. Contact Hoover, 101 E. Maple St., N. Canton, OH 44720.

Room With A View

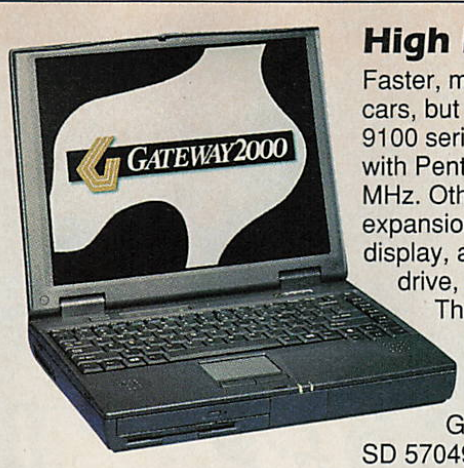
A good family tent has roomy doors, a high ceiling, lots of floor space and large windows. The new Eureka! Suncrest 10 delivers all of that and more.

The free-standing rectangular dome design requires just two fiberglass poles for a fast, sturdy setup. The outer fly covering is made of 1.9-ounce Taffeta nylon that breathes from the inside out, so it lets condensation-building moisture exit and keeps rain out. The special No-See-Um screens ensure that even the tiniest of insects won't buzz in your ear at night.

Although it weighs only 15 pounds 9 ounces, the Suncrest sleeps six and offers 6 ft. of headroom. The tent has a suggested retail price of $300, and is available where camping equipment is sold, or you can contact the company to find the dealer nearest you: Eureka!, 1326 Willow Rd., Sturtevant, WI 53177; 888-245-4984.

Quicker Picker-Upper

One of the nastiest jobs when changing a flat tire—especially with larger size wheels and tires—is wrestling the wheel off and onto the hub. Clever Lever Tire & Wheel Caddie is not a jack, but a tire lifter that rolls under the tire and lifts it. The unit cradles the tire within tilting brackets, so you can easily tilt and rotate the wheel to match the angle of the hub and align it with the lugs. The model MD-22 Clever Lever for pickup truck tires sells for $149.95 from Safe Shop Tools, P.O. Box 4206, Missoula, MT 59806; 800-327-7639.



High Notes

Faster, more power. No, we're not talking about cars, but notebook computers. Gateway's Solo 9100 series notebook PCs pull away from the pack with Pentium MMX processors that operate at 166 MHz. Other features include SDRAM memory with expansion capability up to 192MB, a 13.3-in. XGA display, a combination CD-ROM and floppy disk drive, a MIDI/game port and a fast infrared port. The unit supports hard disk drive capacities up to 3GB and a 32-bit CardBus interface. Prices for Solo 9100s range from $4299 to $5999 from Gateway 2000, 610 Gateway Dr., P.O. Box 2000, N. Sioux City, SD 57049-2000; 800-GATEWAY. PM

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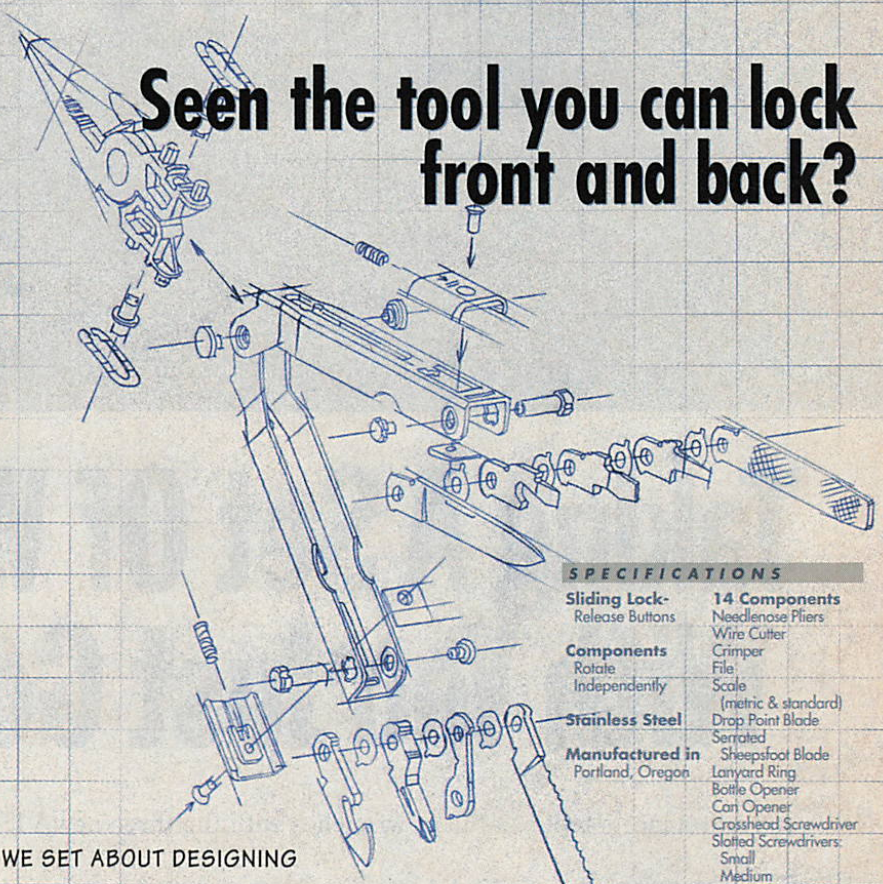

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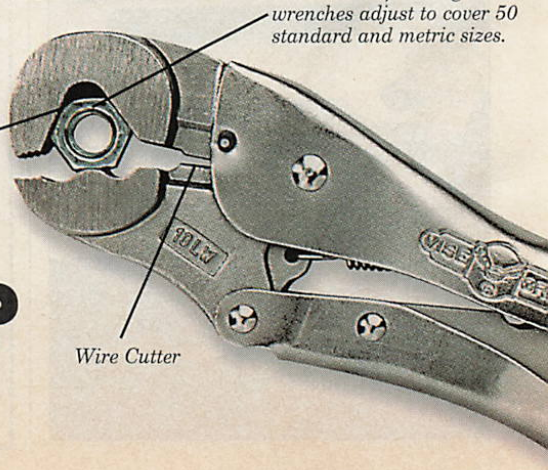
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CAR CARE

CAR CLINIC

BY MIKE ALLEN,
Associate Automotive Editor

Squeeze Play

I'm having the engine in my pickup rebuilt at a local shop. The mechanic had to overbore the cylinders thirty-thousandths of an inch to clean up after a broken ring. He claims the increased cylinder bore won't change the compression ratio. I can't see how that can be. Isn't the compression ratio the difference between the bore and stroke? I don't want to have to burn premium gas in this truck.

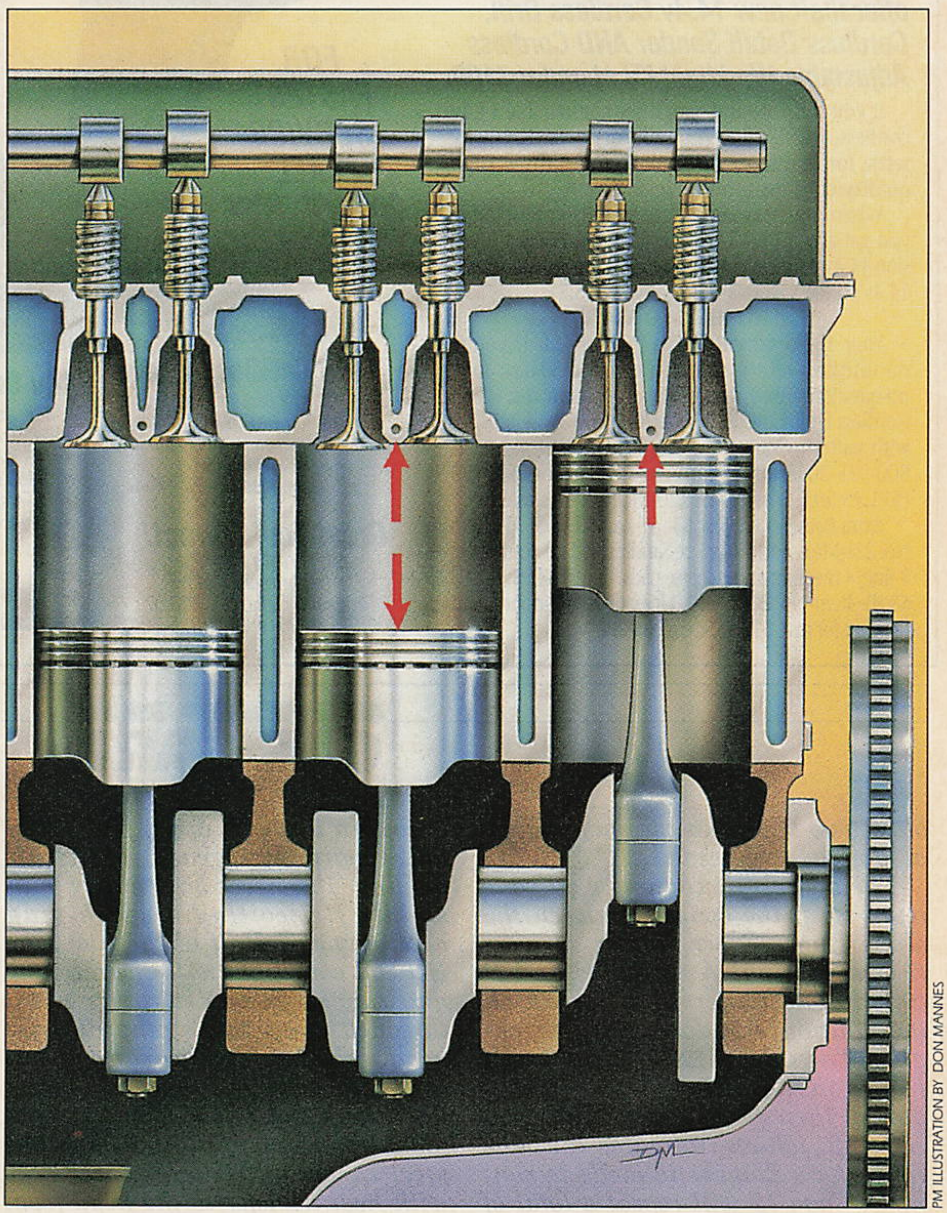
TOM WALKER
BOISE, ID

No, the compression ratio (CR) is not the difference between bore and stroke. It's the proportion between the minimum and maximum volume in the cylinder, hence ratio.

To calculate the minimum volume, you need to add the volume of the dish in the piston crown, the volume above the top of the piston (called deck volume) and the combustion chamber volume in the cylinder head. Calculate the deck volume by multiplying the distance between the top of the block and the top of the piston by π (3.14) and the square of half the cylinder's diameter. The total of all these volumes is then added to the volume displaced by the piston between Top Dead Center and Bottom Dead Center to find the maximum volume. Divide the maximum by the minimum volume to find the CR.

Will boring out your cylinders increase the CR? Yes. But in a typical street (in other words, nonracing) engine, not much. Probably not enough to require low-compression pistons or high-octane gas. To calculate the new CR, you'll need to do the math with the new bore diameter, new deck height and piston crown volume in the equation. Any competent machinist can do this, and he should as he's assembling the engine.

Resurfacing the cylinder heads or the block deck surface even a few thousandths of an inch can change the CR substantially. Don't forget that when the valve seats are resurfaced, the valves will be slightly recessed into the head, increasing the combustion chamber volume slightly. This will partly compensate for the slightly larger swept volume, so your CR probably won't be very different, assuming the pistons are close to the original deck height and crown style.



PM ILLUSTRATION BY DON MANNES

Cracking The Code

I'm in the Air Force and stationed in England. I have a '92 Isuzu Rodeo with a GM 3.1-liter V6 engine. The CHECK ENGINE light came on, so I took it to the local Vauxhall (GM Europe) dealer. He said, "Sorry, mate—it's an Isuzu."

Isuzu in Europe doesn't have the 3.1 engine, so I went to a local shop that's in cahoots with Military Car Sales, and they tried to put it on their GM Tech One scan tool—but the connectors specified didn't mate. Is there any way to get the correct adapter and these codes? CARL POHLMANN
SOMEWHERE IN ENGLAND

Any mechanic who hasn't been asleep since about 1975 ought to know how to short two pins in the diagnostic connector to make the CHECK ENGINE light flash the trou-

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CAR CARE

ble codes. It's all in the shop manual, no scan tool needed.

The diagnostic connector on your truck is in the console between the seats. Run a short jumper wire between terminal A (ground) and B (the diagnostic terminal). Turn on the ignition, but don't start the engine. The CHECK ENGINE light will flash once, followed by a short pause, then flash twice. This is a code 12, which indicates that the computer's diagnostic mode is running. Code 12 will repeat a total of three times, followed by any error trouble codes, each repeated three times, followed by a code 12 three more times. If there are no codes, 12 will flash continuously until you shut the ignition switch off.

All Crossed Up

I recently cross-threaded the No. 2 spark-plug hole in the head of my T100 pickup for the full length of the thread. The dealer chased the threads and said it would be fine, that the plug would hold and not leak. He recommended *not* Helicoiling the threads. So far it's worked for 400 miles. HOMER COX
WARRENTON, VA

I wouldn't take it apart just to try and repair the threads if it's still holding. I've never been happy with simply Helicoiling a spark-plug hole, anyway. Half of the time, the Helicoil comes out with the plug the next time anyway. I'd rather use a threaded insert that's pinned to the head, which involves reaming out the hole several millimeters. There's too little metal in the cylinder head for me to want to do that, and the steel insert or Helicoil interferes with heat transfer to the head from the plug, so that plug runs warmer than the others.

On the other hand, it is a better option than removing the head, welding up the hole and redrilling and tapping it.

If it were my truck, I'd leave that plug in place until it started to misfire, then replace it—carefully—with a precious-metal plug, either platinum or gold-palladium, and never change it again.

Fire And Ice

I've always known that cold weather is hard on batteries. Now that I've moved to a hot climate, I have a lot

SERVICE TIPS

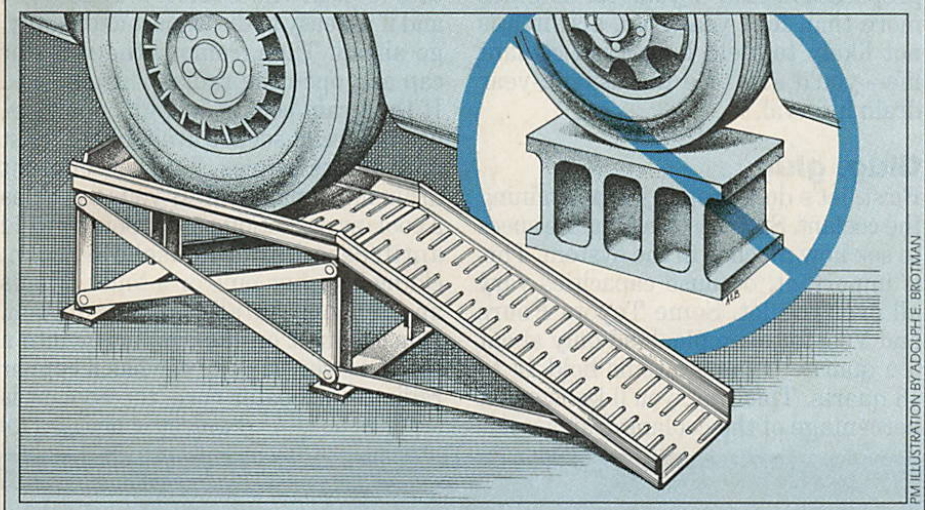
- Pick up a windshield washer check valve (PN 4805010) for your 1993-95 Chrysler Concorde, Intrepid, LHS, New Yorker or Vision to keep the nozzles from freezing.
- Chafed oxygen sensor wires on 1992-95 V8 Ford F-Series and Broncos can trigger ABS and engine warning lights and make speedometer and backup lights inoperative.
- If a 1991-93 Saturn's intermittent wipers activate the battery warning light, a suppression diode (PN 12126220) can correct this.
- Find and fix the damaged vacuum line near the left headlight on your 1992-95 Volvo 850 and you just may get the cruise control working again.
- Two front-wheel bearing kits may stop clunking on acceleration and braking in 1993-96 Volkswagen Golfs, GTIs and Jettas. Order PN 357498625B (4-cylinder) or PN 1H0498625 (6-cylinder).
- Fuel injector cleaner may cause injector corrosion or failure on 1990-96 Nissan pickups, 1991-96 Sentras and 240SXs and 1993-96 Altimas, Maximas, Quests and 300ZXs.

Damocles' Cutlass

CAR CARE TIP

● I saw it being done again. I found one of my neighbors changing the oil on his Oldsmobile, and he had the car sitting up on cement blocks instead of proper ramps or jackstands. And I tell you, it made the hair on the back of my neck get all funny. I promptly went into the garage and got him a pair of ramps.

Cement blocks are simply not suitable for that kind of compressive load. The cement is too brittle and is likely to shatter without warning. Don't ever do this, people. If ramps won't work because you need to remove the wheel, then beg, borrow or steal a pair of proper jackstands. If nothing else, park on a curb.



PM ILLUSTRATION BY ADOLPH E. BROTMAN

of battery trouble. The local mechanics just give me anecdotal evidence. My battery won't stay charged. If I don't use my car for more than two days, it won't start because the battery is dead. I've had it checked twice for a constant drain.

ROBERT BARGER
PANAMA, FL

Hot weather, and particularly hot underhood temps, will make a battery lose more water from the electrolyte and require that distilled water be added more often. (Not an option for sealed, maintenance-free batteries.) A hot battery sulfates more readily than a cooler one, and thus has a reduced service life. Starting a hot-soaked engine requires more current than one at room temp because of the increased friction caused by thinned-out oil.

But none of these things will make your battery go flat almost overnight. You're either severely undercharging your battery, or there's something draining it rapidly, like a trunk or glovebox light that doesn't go off, or an aftermarket alarm system that uses a lot of current. Keep checking. **PM**

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SATURDAY MECHANIC

FLUSHING YOUR COOLING SYSTEM

BY PAUL WEISSLER

DEGREE OF DIFFICULTY
MODERATE

● You take off the cap and look at the coolant. It's a nice shade of green, or maybe red, or maybe even orange. It looks good. Should you leave it in? Unless it's colored orange, the answer is no, especially if it's been two years or more since the last time you drained it.

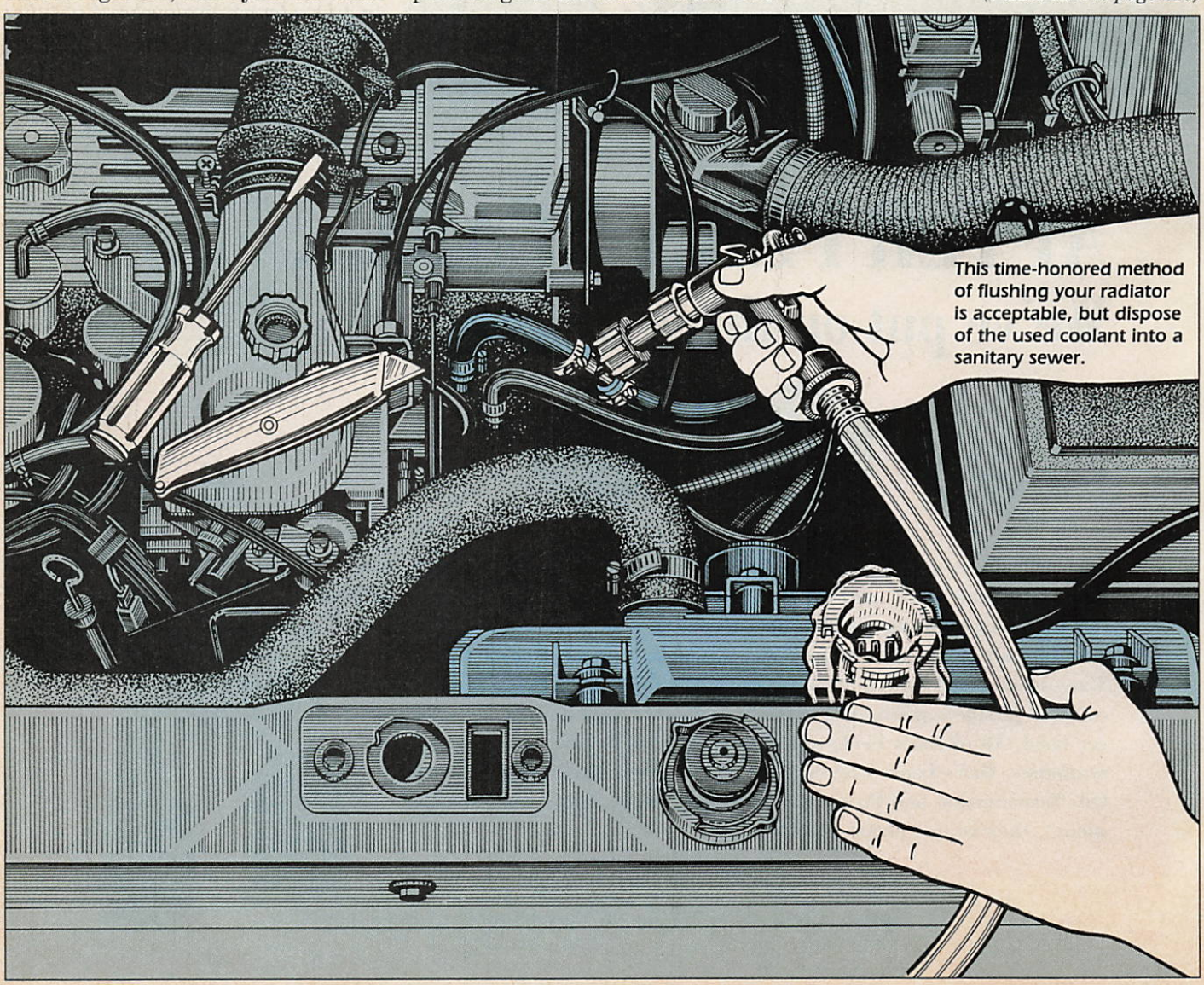
Today's engines are loaded with aluminum components: cylinder heads, water pumps, manifolds, even engine blocks. And the two primary heat exchangers—radiator and heater—are also aluminum. Aluminum needs great corrosion protection to survive, and the corrosion protection in green and red antifreeze is used up in about two years. Orange offers longer life, but if your car came with green or red, you can't switch to orange without a fair amount of preparation. And if your car is much more than four years old, a switch is not likely to yield long-term coolant life—you'd still face the usual 2-year drain interval.

Glug, glug

First, let's do a proper job of draining the coolant. Start by checking the specs to see how much is in the system. This is important, because capacities vary all over the lot. Some Toyota Fours and V6s, for example, hold only about 5½ quarts. Other systems hold 14 to 18 quarts. This way, you'll know what percentage of the coolant drains out.

Start with a cool engine. If the pressure cap is on the engine or radiator, look at the overflow reservoir, and if it's easy to disconnect and empty, go ahead. Then, remove the radiator cap and open the radiator drain cock. If the drain cock is in tight quarters, use a special socket available at most auto parts stores. Let the coolant drain into a pan. Unless your town has a coolant collection setup, pour the old antifreeze into a household drain, clothes-washer pipe or a toilet. That's an environmentally safe approach. Don't pour it on the ground or into a storm sewer. If your car has a copper radiator or heater core, the coolant is

(Please turn to page 110)



This time-honored method of flushing your radiator is acceptable, but dispose of the used coolant into a sanitary sewer.

PM ILLUSTRATION BY RUSSELL J. VON SAUERS

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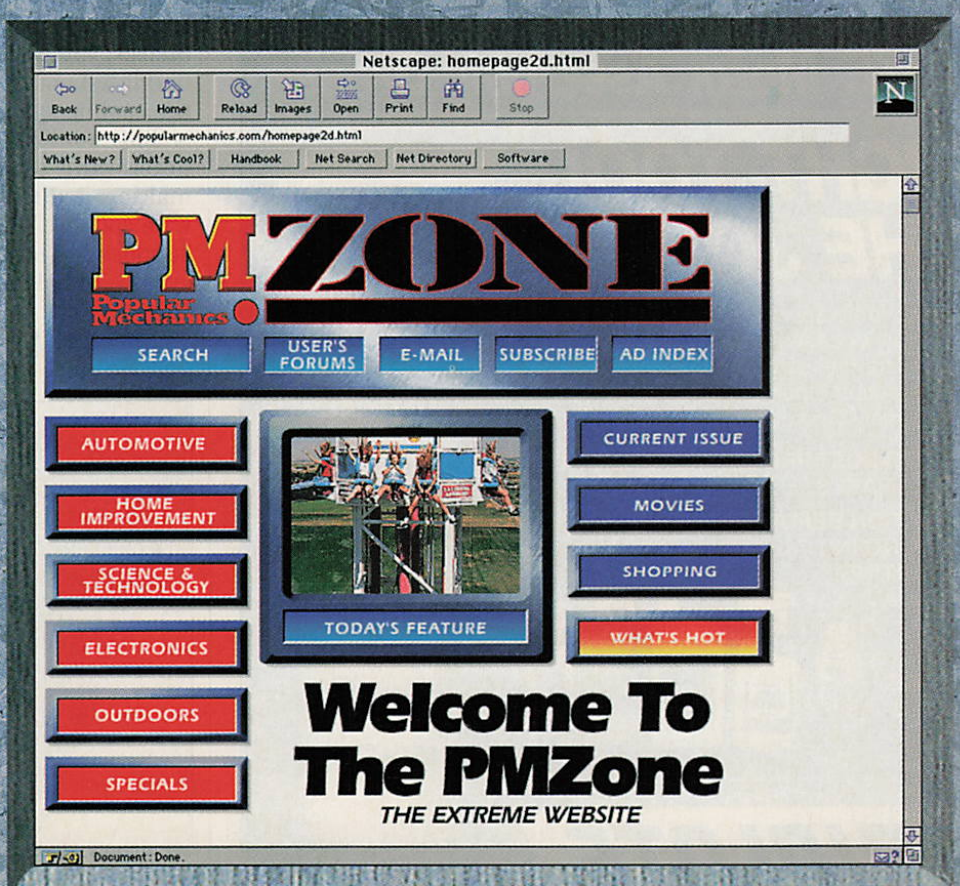

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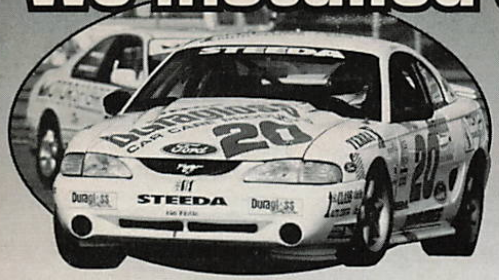

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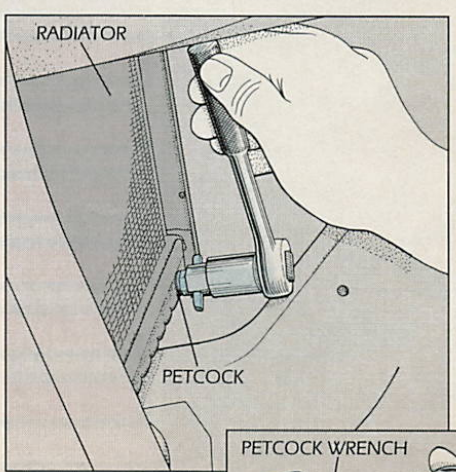
contaminated with lead solder. Many municipalities have hazardous-waste disposal facilities that will take it. Also, in most of the United States it's illegal for professional mechanics to dispose of used coolant, so you may be able to take it to the local shop and ask if they'll handle it.

Next, move the dashboard temperature lever to HOT, so if your car happens to have a heater coolant control valve, it will open. If the pressure cap is on the plastic reservoir, remove the cap, then open the drain cock. No radiator drain cock? Disconnect the lower radiator hose from the radiator. Move the hose clamp back from the radiator neck, slip a thin screwdriver between the hose end and radiator neck to free up the hose, then twist slightly to disconnect the hose. Draining the radiator alone normally should remove 40 to 45% of the coolant. After the first drain, fill the system as well as you can with water, then warm up the engine and let it cool. Drain the radiator again and fill it once more with water. Repeat.

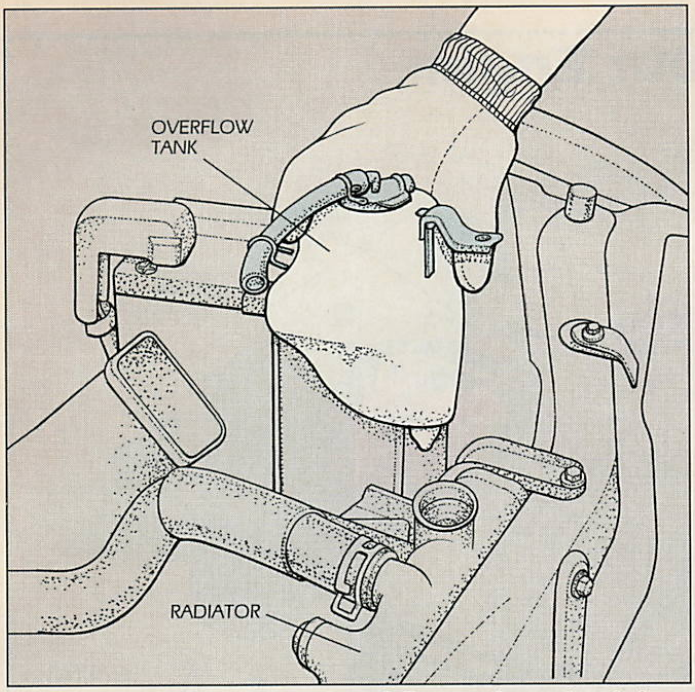
Let it bleed

Now comes the hard part—filling the system. If the system holds 12 quarts, you want to install 6 quarts of undiluted antifreeze, or exactly half of the cooling system's capacity.

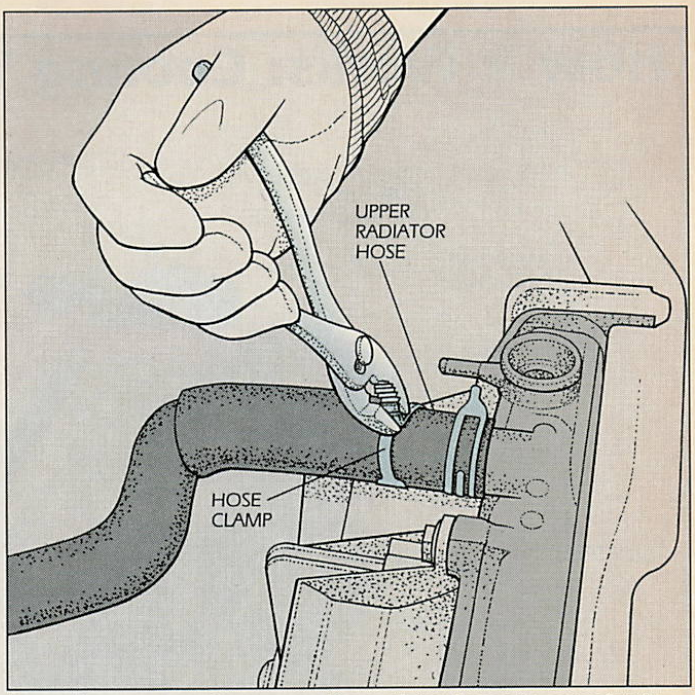
The cooling system has lots of nooks and crannies that trap air, making it difficult to fill the system with coolant. The fill cap and neck are supposed to be at the high point of the system to help air bleed out, but often they aren't. And even if they are, you need all the natural help you can get. So jack up the front of the car,



Start by unscrewing the petcock on the radiator. You may need a special wrench.



Remove the overflow tank, and carefully pour the coolant in it into your drain pan.



It may be necessary to remove the radiator hoses to completely drain the system. Remove the clamps and twist the hoses off.

which gets the coolant fill neck as high as possible.

Check for air bleeds on the engine. Sometimes you'll see an obvious air bleed, such as a boltlike item threaded into a hose. If there's an air bleed, open it. If there are several, open them all. If you have access to a factory service manual or PM CD-ROM for your car, check it for a coolant fill procedure.

Pour in the required amount of antifreeze slowly until you see coolant oozing out of the open air bleeds. Then close the bleeds and top off the system with the remaining antifreeze and then plain water.

If the system has a heater coolant valve, close it by moving the temperature control lever or knob to COLD. With the engine running at fast idle and warmed up, have a helper move the lever or knob to HOT while you listen at the coolant valve. If after the first rush of coolant you hear a continuous gurgling noise, there's still air in the coolant, and you should be prepared to watch the coolant level in the reservoir over the next few weeks.

Picking the right antifreeze

Most antifreeze is made with a base chemical called ethylene glycol. Green dye is used in most brands, except Toyota, which uses red. Extended-life antifreezes, also with green dye, were on the market until two years ago. But the newest entry is a superlong-life antifreeze with a totally new rust/corrosion inhibitor developed originally for heavy-duty use (such as trucks). The original, from Texaco (used as original equipment by GM), is called Dex-Cool. The latest is Prestone Long Life 5/100. These two are orange.

The rust/corrosion inhibitors vary, but if antifreeze is green, assume that its life in a car with a lot of aluminum components is two years or 30,000 miles—whichever comes first. You can push that to a third year if the

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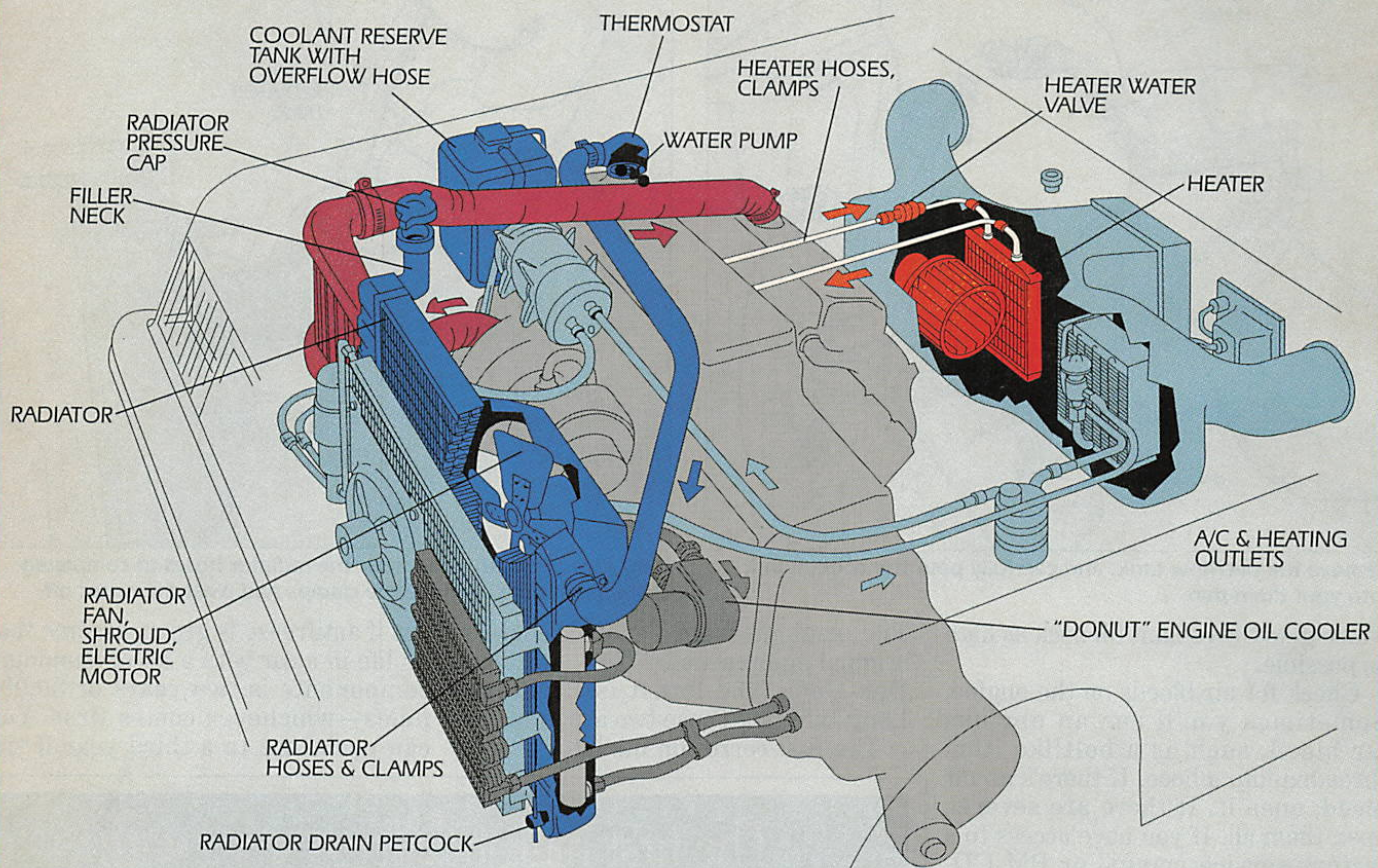

● A coolant pump, or water pump, circulates the antifreeze and water mixture between the engine and the radiator. After the coolant circulates through the engine, the pump pushes it out the upper radiator hose into the radiator, a heat exchanger made of metal tubes (aluminum on today's cars) to which fins are attached. The fins draw away heat and dissipate it to the air that is drawn through the radiator by fans and the forward motion of the car. The cooled coolant is drawn from the radiator through the lower radiator hose and back into the engine by the pump, and the cycle starts all over again.

When the engine is cold, coolant circulates only within the engine, so engine heat warms it up faster. At about 195° F, the coolant heats a temperature-sensitive valve (the thermostat) that opens to allow the coolant to flow through the radiator. The thermostat may be located at the engine outlet, in line with the upper radiator hose, or at the inlet to the water pump (the preferred location on today's cars).

The coolant also flows through hoses into and out of the heater, which, like a miniature radiator, gives up its heat to the surrounding air. In this case, however, the heated air is blown into the passenger compartment.

Raising the cooling system's pressure also raises the coolant's boiling point, so the radiator cap (which also could be on the engine or on the separate reservoir) has a pressure valve to raise the pressure in the cooling system by about 15 psi. This increases the boiling point of the coolant by about 40° F. So, the boiling point of a 50/50 mix of antifreeze and water in a properly functioning system is about 265° F or higher.

engine is all cast-iron. "Toyota Red" is a specific formula, but if you drain it, you can replace it with any name-brand American formula. Here again, the replacement interval is two years or 30,000 miles.

The inhibitors in orange antifreeze are not chemically compatible with what's in green or red. However, if you have at least 5000 miles on the green, the chemical bond with the aluminum components is "solid." So if you want to get extended life with a coolant installation, just do a thorough drain-by-dilution, at least three times. The coolant you drain out should be virtually clear, like the color of water. If it's still green, you have to repeat the process until it's all out.

With the radiator and reservoir drained, pour in the amount of antifreeze necessary—there should be plenty of room—and then top up with water. Follow the procedures we've discussed to ensure a full system.

Remember: You can do this only as a maintenance procedure, not as a final step when replacing a part, such as the water pump and radiator.

What about "pet-friendly" or "safer" antifreezes made with a base of propylene glycol? The name brands (Sierra and Prestone Lo-Tox) will do the same job as ethylene glycol. But they cost a little more and actually require a greater quantity to provide the same freeze protection, and in truth, they're only a bit less hazardous.

They aren't sweet, and consequently aren't as likely to be consumed by toddlers or pets. Don't rely on this, however. Store all unused coolant, low-tox or not, safely. Dispose of all drained coolant in a sanitary sewer and sweep up or rinse away any spillage. **PM**

tal decoders with limited intelligence and a fixed microprocessor. Theta Digital uses high-speed programmable digital processing chips, and, as a result, they can do a more complete job of decoding the digital signal. Mid-priced CD players don't have the computer power to deal with time and phase, which results in a lower-resolution output. Theta CD players incorporate Motorola's 56000 series chips, which deliver 48-bit processing for a manufacturing cost of about $100 a chip. A mass-market CD player, by contrast, typically packs a 20-bit processor that costs about $2 to $3.

Using separate power supplies and transformers for digital and analog circuitry is also important to the final result. Isolating power supplies minimizes the amount of spurious noise that occurs when the signal goes from digital to analog and analog to digital. Theta's $11,000 CD player is actually three separate chassis: a digital section, an audio section and the transport. Sinclair says they do it that way so that noise doesn't radiate from one section to another. The flagship system also uses Class A analog circuitry, as opposed to the more common and less expensive Class A/B type, which produces less distortion and a more controlled signal.

Perfect relationship?

Maybe no relationship in the high-end audio world is closer than that between stylus, cartridge, tonearm and turntable. "The trick in audio," says Harry Weisfeld, president of turntable and tonearm manufacturer VPI, "is to get the sound as neutral and as musical as possible. To us, CD *never* does that because it doesn't have enough information."

The VPI tonearm alone sells for $2300—that's without the $2300 turntable, a cartridge or a stylus. Although its parts are made by computer numerical control machines, the tonearm is assembled by hand. Parts that fit inside other parts must have a perfect fit, or the defect will be audible when amplified. "If it's not a tight fit, you can hear the glue. So you need to press the parts together so that they become one solid piece. A machine can't do that," Weisfeld says.

Wiring and connectors are also critical, and VPI uses pure copper wires and silver solder to guard against oxidation. Also part of the recipe are gas-tight Lemo connectors at $19 a pop. Oxidation produces dielectrics that change the sound. "Low-level signals can be one-half or one-quarter of a microvolt," Weisfeld says. "There's got to be a very clean connector because those signals are going to be amplified a thousand times. It makes no difference if you buy a $30,000 amp or a million-dollar amp if you don't feed it a clean signal. All the signals come from the platter and the tonearm."

On the turntable side, isolating the motor and absorbing noise-producing vibrations are the most critical issues. VPI's least-expensive turntable has a rumble rating so low that it can't be measured, but that doesn't stop the company from addressing it. "When the diamond goes through the groove of an LP," Weisfeld says, "it's soft like going through jello. The diamond will vibrate the entire platter. If the platter can't suck up all the vibration, it goes back into the diamond."

What's in a speaker?

You can find loudspeakers at Radio Shack for under $100 a pair or in a by-invitation-only audio salon for $7500 a pair. What's the difference? Materials, design and labor, according to Kevin Voecks, vice president of engineering for Revel, a recently formed high-end speaker company under the Harman Consumer Group.

Most of the cost in high-end Gem speakers is materials-driven. The use of titanium midrange drivers, for example, costs the company about five times more than polypropylene drivers would. Does it yield a fivefold boost in quality? "Yes," Voecks insists without reservation. "Titanium provides a new level of transparency. You hear more of the music."

While testing materials for the cabinet and baffle for the speakers, Revel designers recognized that speakers rocking on stands had a detrimental effect on the sound, too. So they built extremely heavy, massive stands that retail for $1500 a pair. The stand's job is to reduce the output of the cabinet, and the sand-filled stands are veneer-matched to the cabinets of the speakers.

It's a bit easier to understand the costs involved in the accompanying 1000-watt, $7500 subwoofer package ($10,000 if you spring for the second woofer). The sub is a 2-piece job, with the electronics stored in a separate box that can be placed near the stereo system for customers who want to maintain the shorter-the-signal-travels-the-better-the-purity route of the signal path.

British loudspeaker manufacturer Ruark is a typical shoestring-budget high-end audio company. One area of emphasis at this company is cabinet design and construction, in terms of both sound and aesthetics. That includes strategically placed bracing and double-layer construction to keep standing waves and coloration to a minimum. Ruark also touts its crossover networks, the components in a loudspeaker that separate the signals and direct them to the proper driver—woofer, midrange or tweeter. Most low- and midlevel speakers use printed circuit boards for the crossover function as a cost-saving feature. Ruark hardwires its crossovers directly to the terminal panel. Special attention is also given to the layout of components to avoid interaction of components via radiation, and every connection from the terminals to the drive units are soldered to reduce the chance of oxidation over time.

Wired up

The final link in the chain is the wiring between the components. Those interconnects between components and speakers are also the most ridiculed by high-end audio critics who believe hardware-store lamp cord delivers an electrical signal as aptly as a $50-per-foot speaker wire. According to Stephen Hill, president of specialty cable maker Straightwire, you're getting reliability, quality and service for the extra bucks. Straightwire's speaker wire ranges from 45 cents to $60 a foot, and 1-meter RCA interconnects span a range from $10 to a breathtaking $700 a pair.

The Straightwire package delivers try-before-you-buy convenience, guaranteed trade-in-for-a-trade-up bonus and free cable re-termination should the connectors oxidize. The company cites electrolytic tough pitch (ETC) copper at the base level and ultrapure copper wire with individual insulating stands at the high end of the line to guard against corrosion or oxidation.

But it doesn't end there. You can spend thousands just for a set of 8-ft. cables to connect your amps to your speakers. MIT's OP^2 Terminator Interface is priced at a measly six grand. These cables use a patented passive network technology that allows the audio components to deliver linear full frequency response. The speaker interface connects only to the positive ("hot") output terminals of each power amp channel, which eliminates any possible ground noise. The interface wiring system operates the amp in a bridged mode to deliver twice the signal voltage that one channel of the power amp can deliver by itself.

The materials and design that go into high-end audio are generally quantifiable. But there is no denying that there is something else at work.

Prestige.

In a world where you may be judged by your Rolex watch, your Oxxford suit with working buttonholes or your Mercedes-Benz SL600, it doesn't hurt to own a Mark Levinson amplifier either. **PM**

BREAKING THE SOUND BARRIER (Continued from page 55)

to the boarding ladder and started climbing. Then there was the long wait as the B-29's engines fired, the big bird began its takeoff roll and lumbered up to the drop altitude. I sat on a metal box inside the plane, ignoring my safety belt against the regulations. At 5000 ft., I nudged Ridley and said, "Let's go." We walked back to the bomb bay hatch and strode through. There was the little X-1, dangling in all that wind and cold and thinning air. Every move was torturous at this altitude. Getting into the X-1 on a good day was tiring enough. But I struggled through, wangled the hatch closed with the help of a 10-in. piece of broomhandle I'd fashioned for the purpose (because of the limits imposed by my broken ribs) and continued checking the X-1's pressurization, fuel delivery and controls.

Richard Frost, Bell project engineer, was flying low chase that morning, and Lt. Bob Hoover was flying high chase well ahead of the B-29, both in Lockheed P-80s. In the standard routine, Frost would pull into a slight climb as I lighted the first chamber, aiming for Hoover's P-80 about 10 miles ahead. I would try to pass Hoover at relatively close range as the fuel supply depleted, and he'd follow me down for an unpowered landing on the lakebed.

Everything was set inside X-1 as Cardenas started the countdown. Frost assumed his position and the mighty crack from the cable release hurled the X-1 into the abyss. I fired chamber No. 4, then No. 2, then shut off No. 4 and fired No. 3, then shut off No. 2 and fired No. 1. The X-1 began racing toward the heavens, leaving the B-29 and the P-80 far behind. I then ignited chambers No. 2 and No. 4, and under a full 6000 pounds of thrust, the little rocket plane accelerated instantly, leaving a contrail of fire and exhaust. From .83 Mach to .92 Mach, I was busily engaged testing stabilizer effectiveness. The rudder and elevator lost their grip on the thinning air, but the stabilizer still proved effective, even as speed increased to .95 Mach. At 35,000 ft., I shut down two of the chambers and continued to climb on the remaining two. We were really hauling! I was excited and pleased, but the flight report I later filed maintained that outward cool: "With the stabilizer setting at 2°, the speed was allowed to increase to approximately .95 to .96 Mach number. The airplane was allowed to continue to accelerate until an indication of .965 on the cockpit Machmeter was obtained. At this indication, the meter momentarily stopped and then jumped up to 1.06, and the hesitation was assumed to be caused by the effect of shock waves on the static source."

> **"I had to tell somebody, anybody, that we'd busted straight through the sound barrier."**

I had flown at supersonic speeds for 18 seconds. There was no buffet, no jolt, no shock. Above all, no brick wall to smash into. I was alive.

And although it was never entered in the pilot report, the casualness of invading a piece of space no man had ever visited was best reflected in the radio chatter. I had to tell somebody, anybody, that we'd busted straight through the sound barrier. But transmissions were restricted. "Hey Ridley!" I called. "Make another note. There's something wrong with this Machmeter. It's gone completely screwy!"

"If it is, we'll fix it," Ridley replied, catching my drift. "But personally, I think you're seeing things." **PM**

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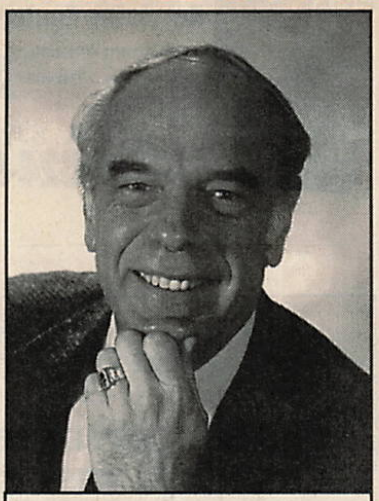

Dr. Richard Huemer is one of America's leading health practitioners and recommends Prostsafe to all of his male patients for maintaining great prostate health.

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Fact #1: Virtually all cases of benign prostatic hyperplasia (BPH), or prostate enlargement, result from hormonal imbalance. In middle age and beyond, a man's testosterone declines while other hormones begin affecting him more.

Fact #2: If not controlled, this imbalance causes the prostate to enlarge and eventually pinch off the urethra, the tube that carries urine from the bladder out through the tip of the penis. This causes the symptoms of BPH including frequent trips to the bathroom, with difficulty starting and stopping.

Fact #3: Prostate health can be maintained at any age by addressing the causes of the body's hormonal imbalance.

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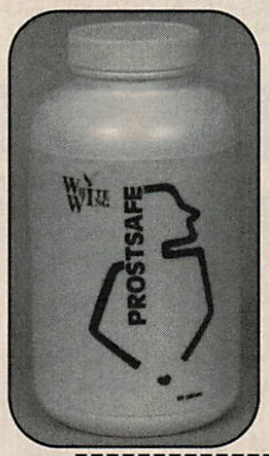

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"My sex drive has improved," says W. Rahn, of Ripon, WI.

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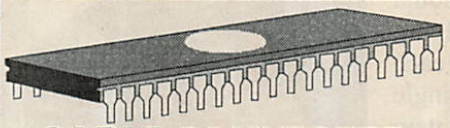

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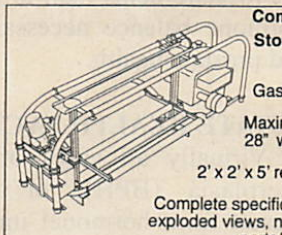

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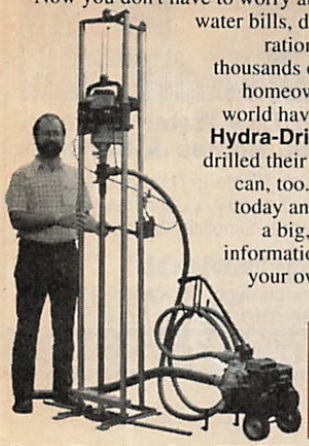

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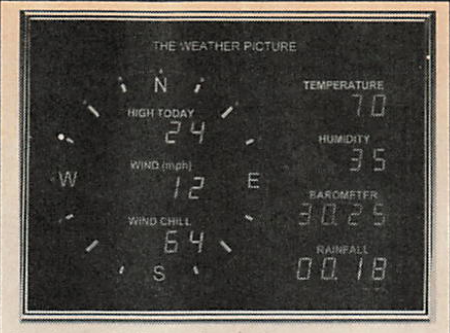

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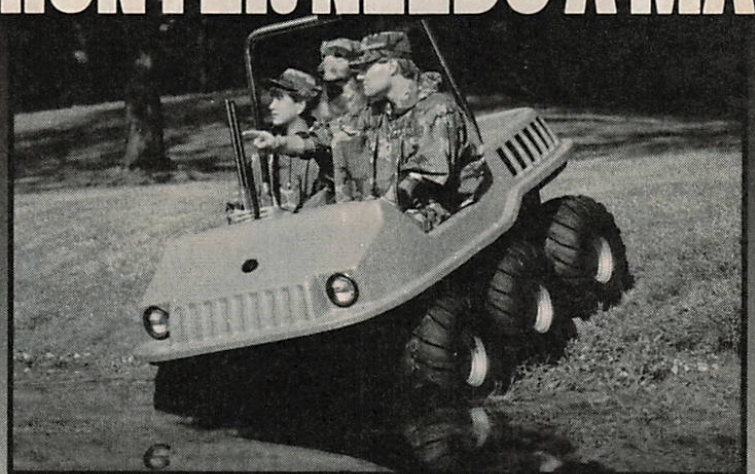

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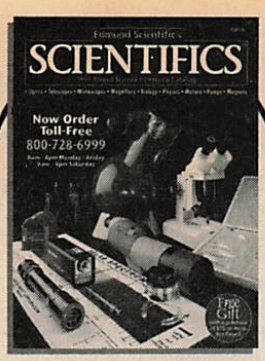

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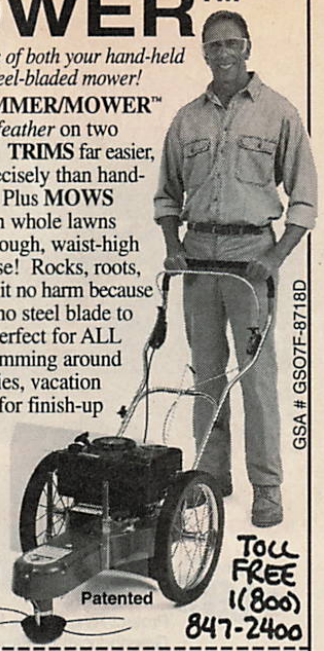

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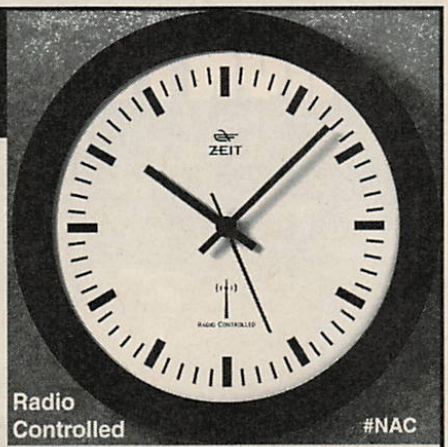

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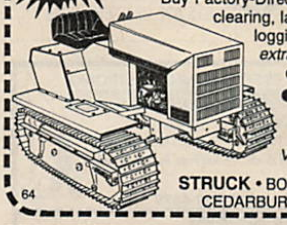

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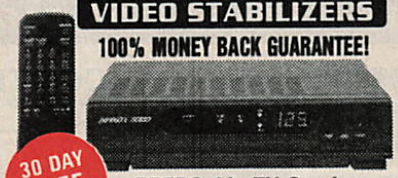

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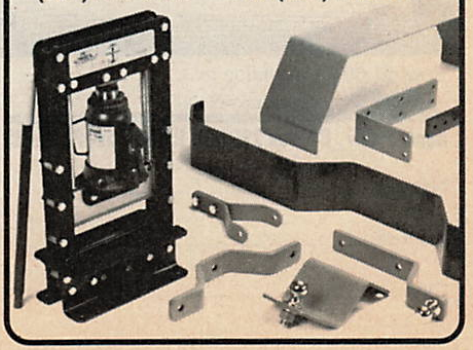

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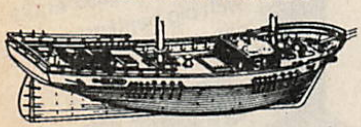

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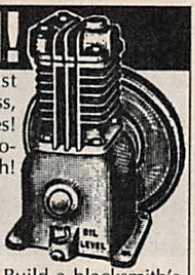

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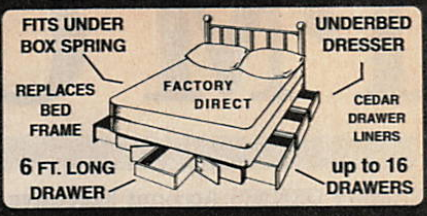

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